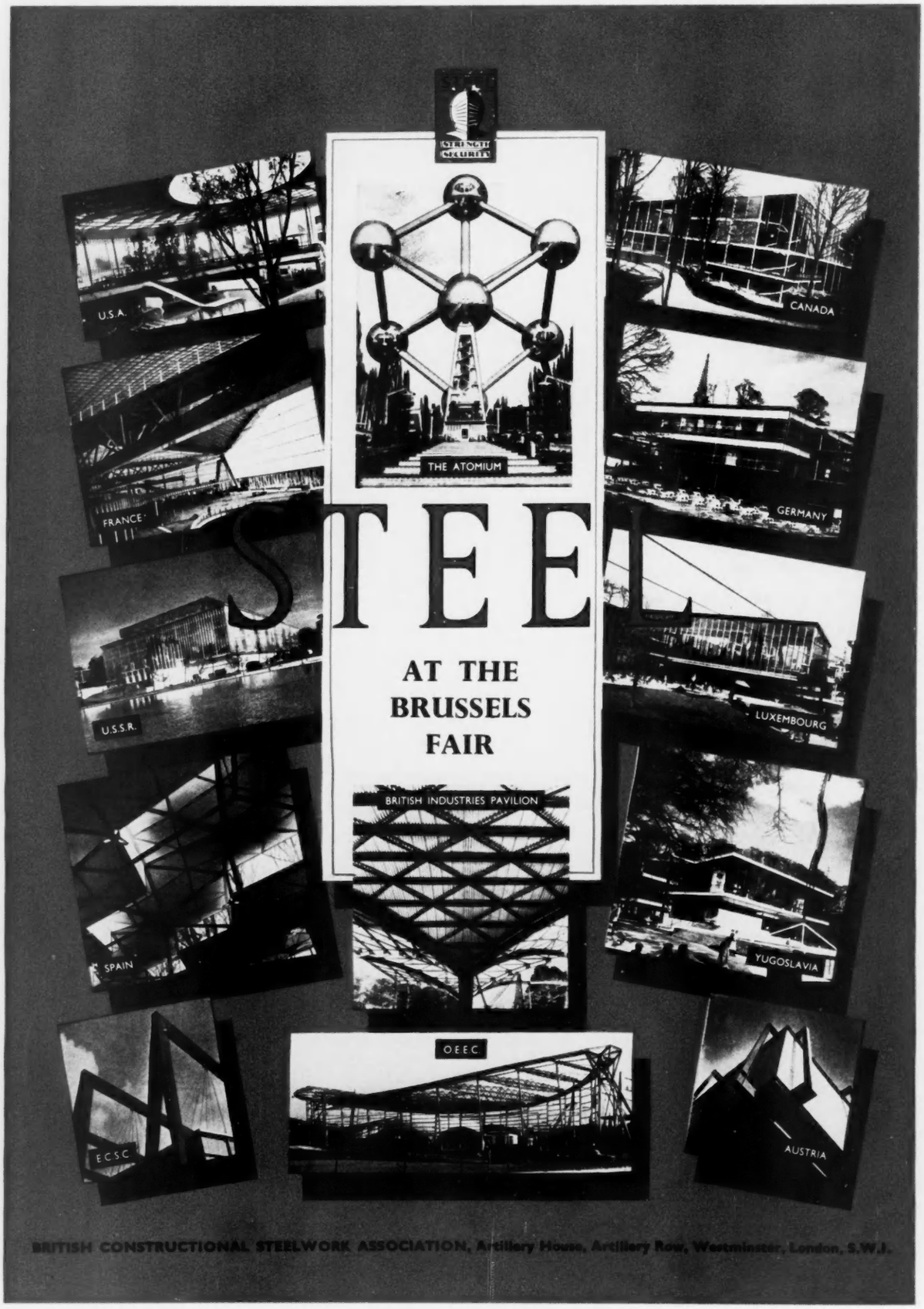
The Engineer

NOVEMBER 14, 1958 28 ESSEX ST., STRAND, LONDON, W.C.2 TWO SHILLINGS



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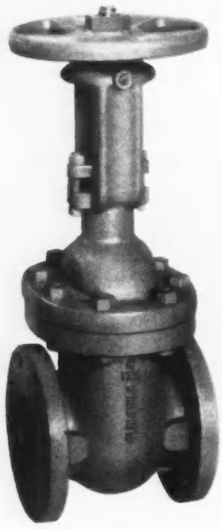

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THE ENGINEER

Established 1856

No. 5364 **NOVEMBER 14, 1958** VOL. 206

EDITORIAL CONTENTS

Leading Articles

F.B.I. and Nationalisation . . . 751
M.C.T. . . . 751
Unhappy Railways . . . 752
Rennie or Smeaton for the Institutions ? . . . 752
Train Accidents . . . 753

Articles

100 Years Ago . . . 753
T. Haas Simulated Service Life Testing. No. I . . . 754
R. S. Bem Effect of Phosphorus on Intergranular Corrosion of Aluminium Brass . . . 756
F. Nixon James Brindley Commemoration . . . 760
C. D. Harbury Rural Sites for Engineering Firms . . . 762
Pipe Clips . . . 763
E. C. Poultney Notable British Locomotives of 1908. No. I . . . 764
Public Works Exhibition. No. II . . . 770
Marine Radar Series . . . 774
Railway Equipment Exhibition . . . 775
Oilfield Trailers . . . 776
New Technological Award . . . 777
Faraday House Engineering College . . . 777
Practical Training for Electrical Engineers . . . 777
Electricity Bulk Supply Tariff for 1959–60 . . . 777
London Colney By-Pass . . . 777
Hollerith Engineering Training School . . . 778
Integrated Airframes . . . 778
Icebreaker Design and Building . . . 778
Engineering Department of Valve Factory . . . 779
Variable Angle Spindle Moulder . . . 779
Unusual Road Repair Task . . . 779
Lightweight Portable Power Chain Saw . . . 780
High-Speed Automatic Gauging Equipment . . . 780

Continental Section

New Signalling at Frankfurt . . . 782

American Section

Higher Fidelity . . . 785
Hot Exponential Facility for Nuclear Reactor Development . . . 786
Large Trenching Machine . . . 786
Combination Strip and Powder Rolling Mill . . . 787

LETTERS Dirty Hands. Graphical Method for Oblique Bending . . . 768

BOOK REVIEWS . . . 768

NEWS AND NOTES Industrial and Labour Notes . . . 781
Personal and Business . . . 788
British Patent Specifications . . . 789
Forthcoming Engagements . . . 790

INDEX TO ADVERTISERS : PAGE 143 **CLASSIFIED ADVERTISEMENTS : PAGE 135**

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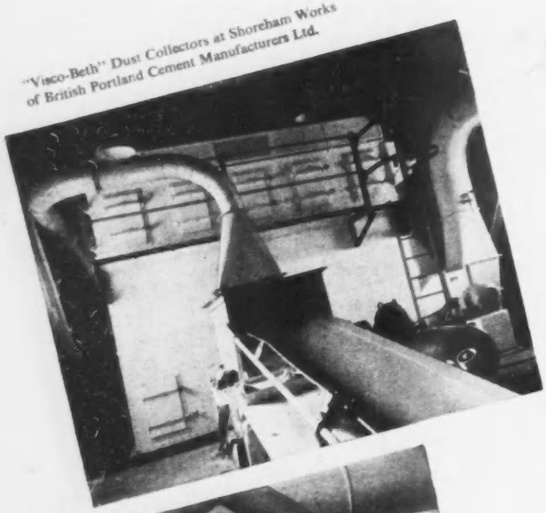

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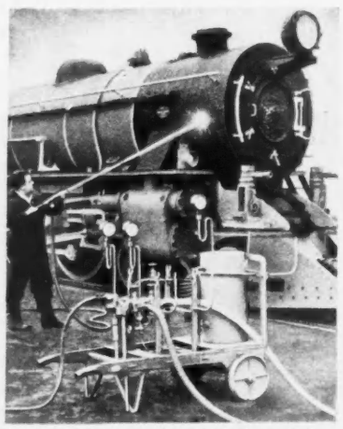

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(Above) Four 320/60 h.p., 660/370 r.p.m., N-S variable speed a.c. motors, with L.S.E. control panels, driving Allen pumps at the Norton pumping station of Liverpool Corporation. (Corporation Water Works Engineer, Mr. J. H. T. Stilgoe, M.Inst.C.E., M.I.W.E.)

(Below) A 720 h.p., 420 r.p.m. squirrel-cage motor, weatherproof, water cooled, for circulating water pump drive

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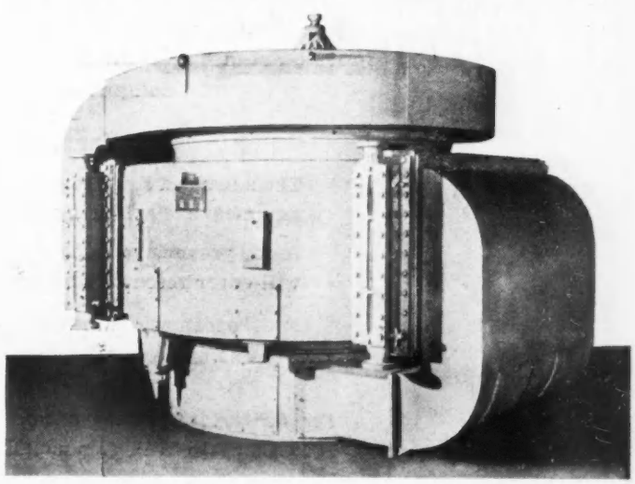
The N-S variable speed a.c. motor has outstanding advantages for use where efficient variation of pump output is required, under hand or automatic control.



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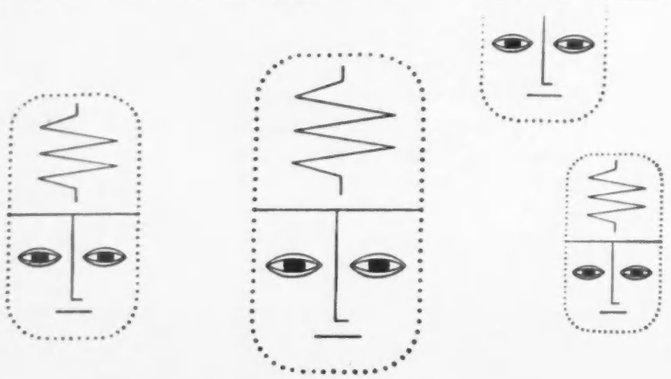

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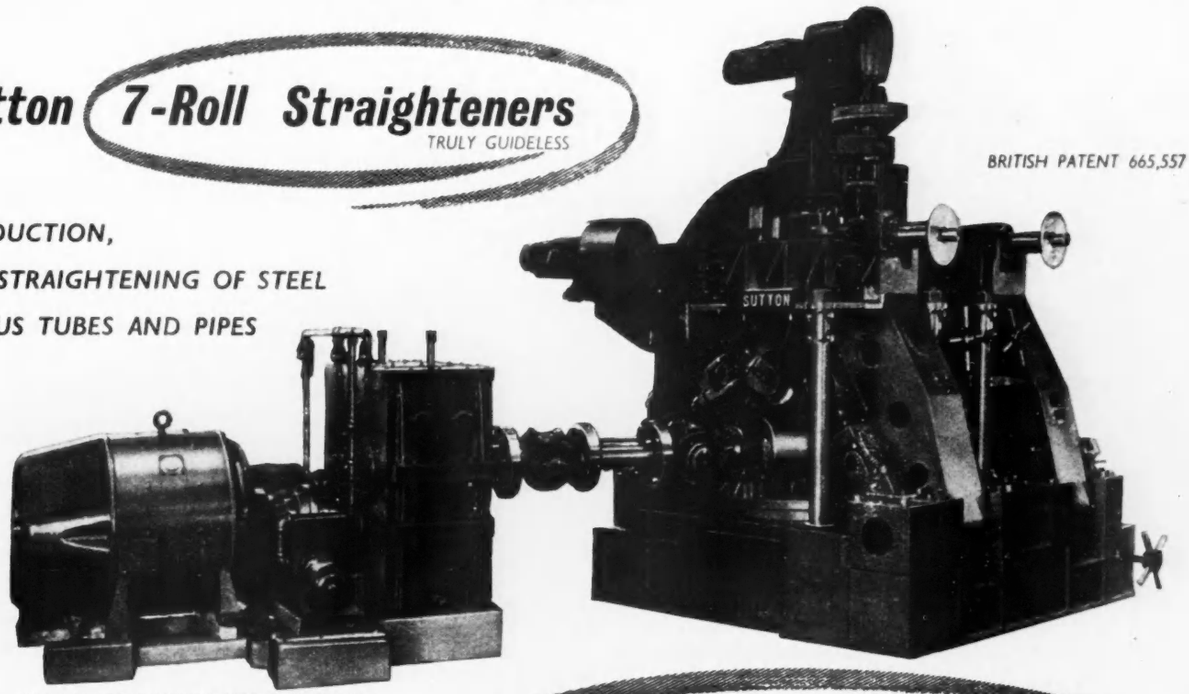

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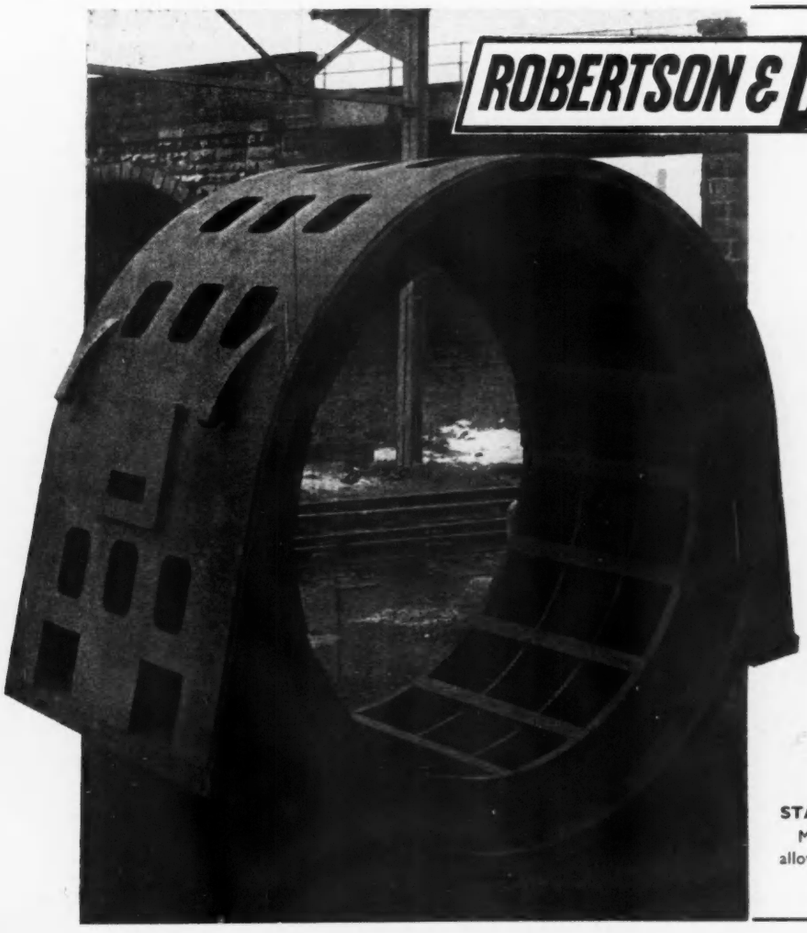

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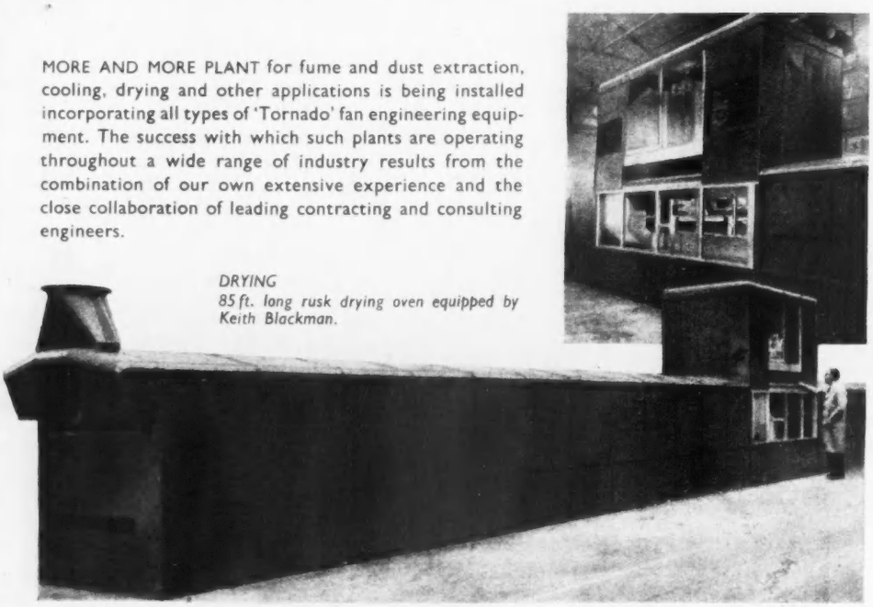

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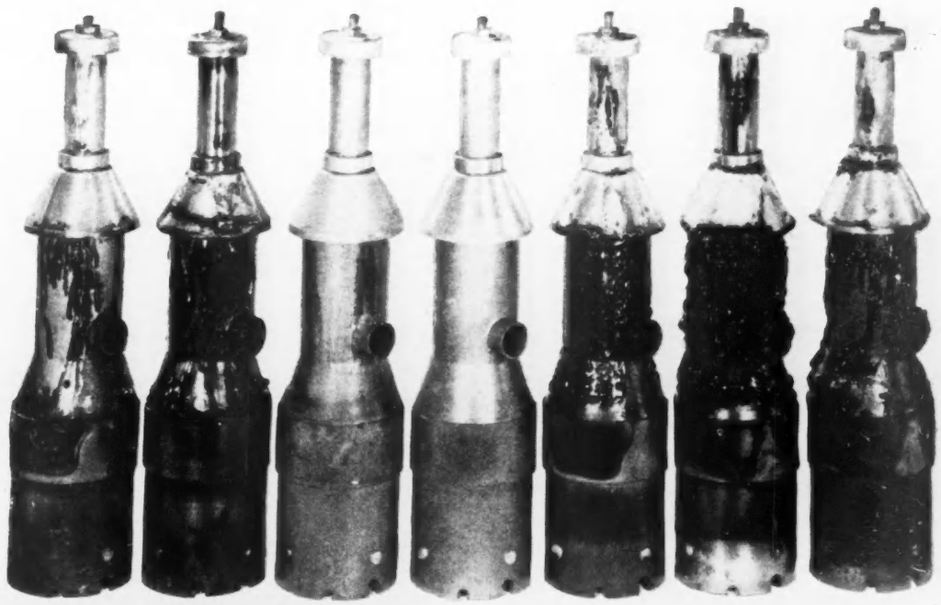
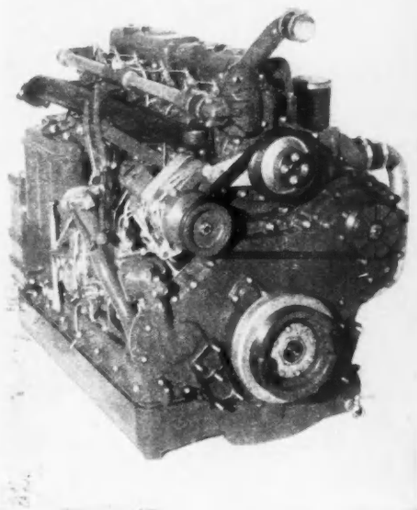


. . . in pump assemblies

Jet assemblies used in a SPEEDIVAC* Model 203 vapour diffusion pump during a test in which the pump operated for fifteen minutes and then air was admitted for five minutes. The jet assembly in the centre using MS703 silicone fluid had survived over 1,000 such cycles yet remained clean. The organic fluids in the other assemblies either failed or lost the ability to pump down to a high vacuum.

**Trade name of Edwards High Vacuum Ltd.*



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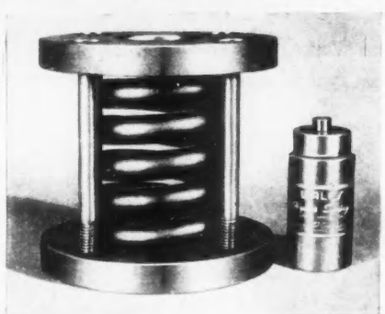

. . . in liquid springs

A steel coil spring and a liquid spring of equivalent performance are shown. The liquid spring contains a silicone fluid which is highly compressible, will show little change in viscosity over a wide temperature range and will not break down even at high temperatures.

You are invited to write for full information about the properties and applications of silicone fluids. Literature on the many other MS silicone products including rubbers, resins, lubricants, compounds, electrical insulants, release and antifoam agents, is also available on request.

MS

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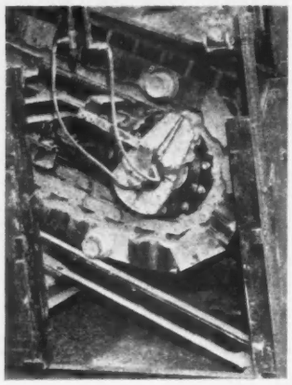
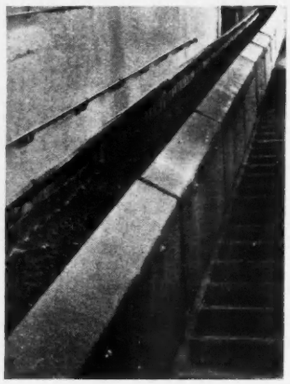
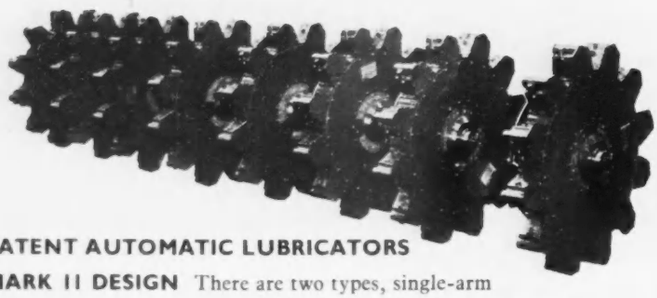
An 18" x 10" x 450' centres x 100 T.P.H. conveyor has since been supplied to Messrs. Associated Portland Cement Co. Ltd., for White's South African Portland Cement Co. Ltd. Lichtenburg Works and orders are on hand for two 40" x 10" catenary-type x 60' centres continuous elevators and two 18" x 5" conveyors for their Johnsons Works, to be fitted with our latest type of lubricator.







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MARK II DESIGN There are two types, single-arm and multi-point, as illustrated, both of which give effective lubrication of chain and outboard rollers with the absolute minimum of attention and unskilled operation. Mark I prototype has been in operation for 3 years under the most arduous conditions in the Hope Cement Works of Messrs. G. & T. Earle & Co. Ltd. Both types have been exported in quantities for elevators and pig casting machines.

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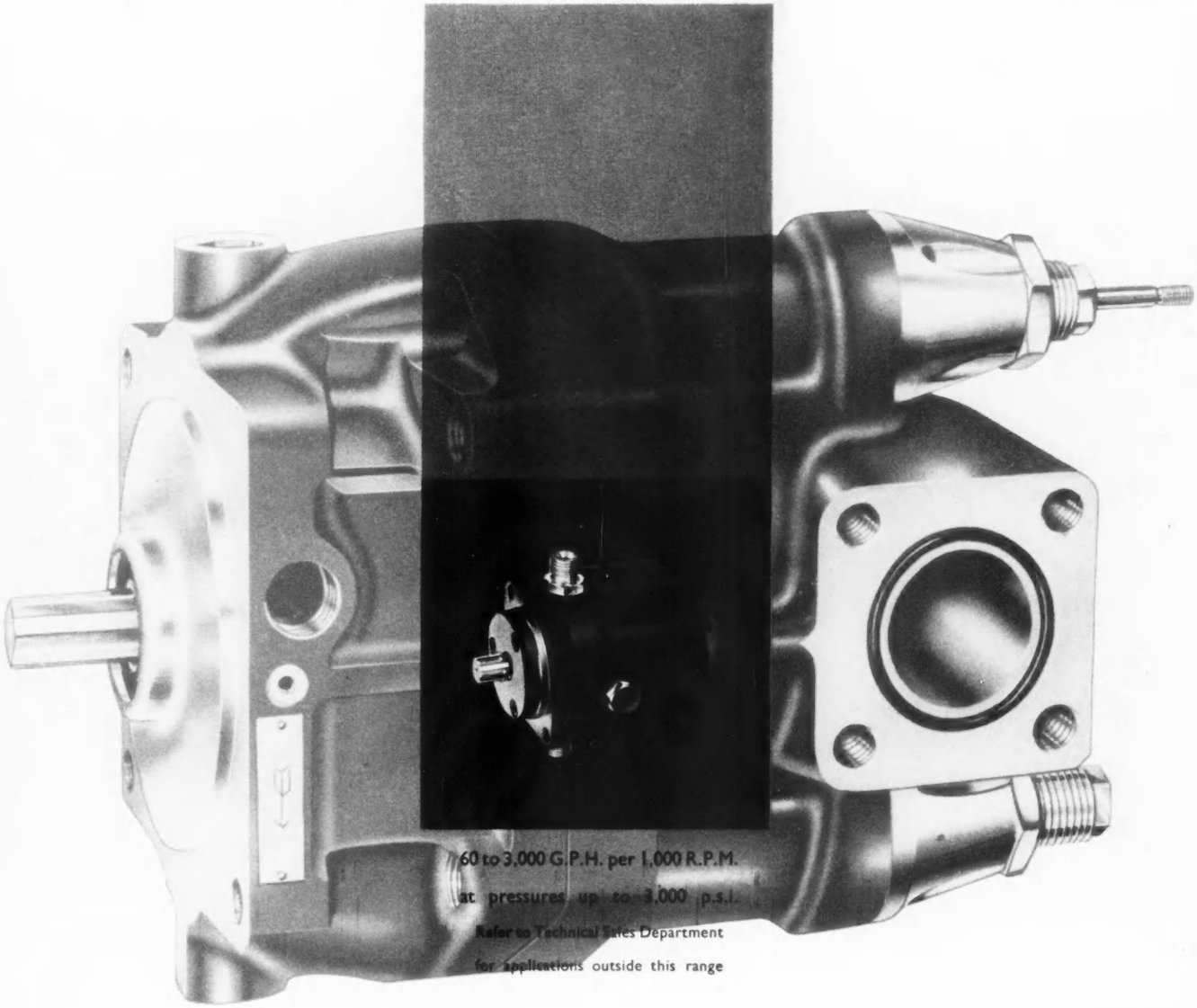

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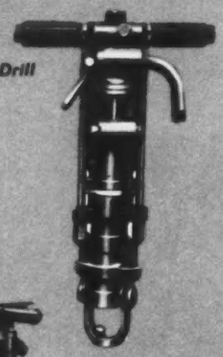
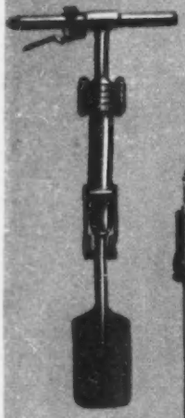


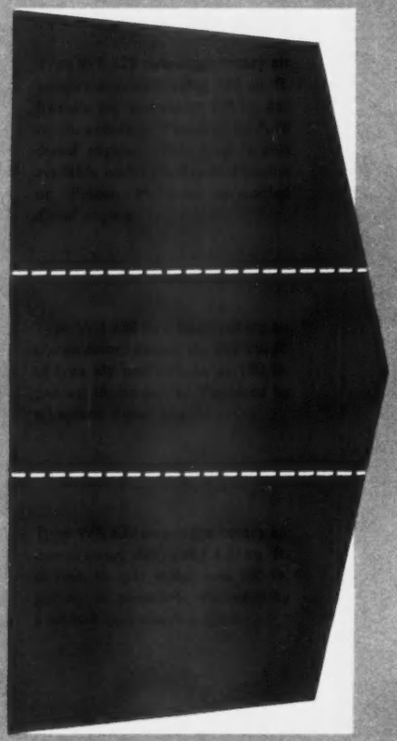
CB 268 Rock Drill

RB 440 Concrete Breaker



CD 5 Clay Spade

SR 10 Rammer



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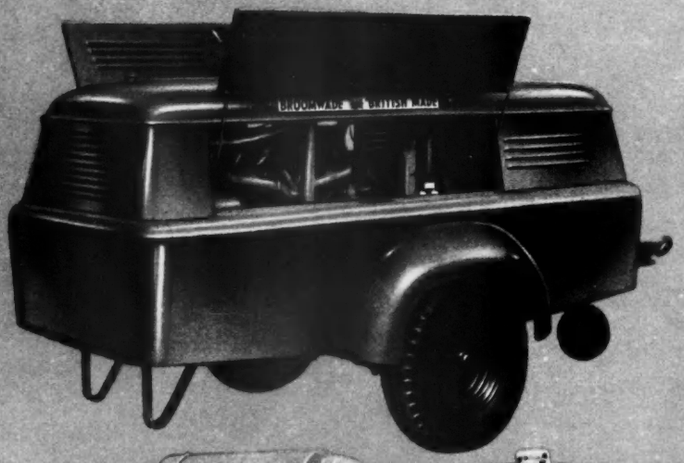

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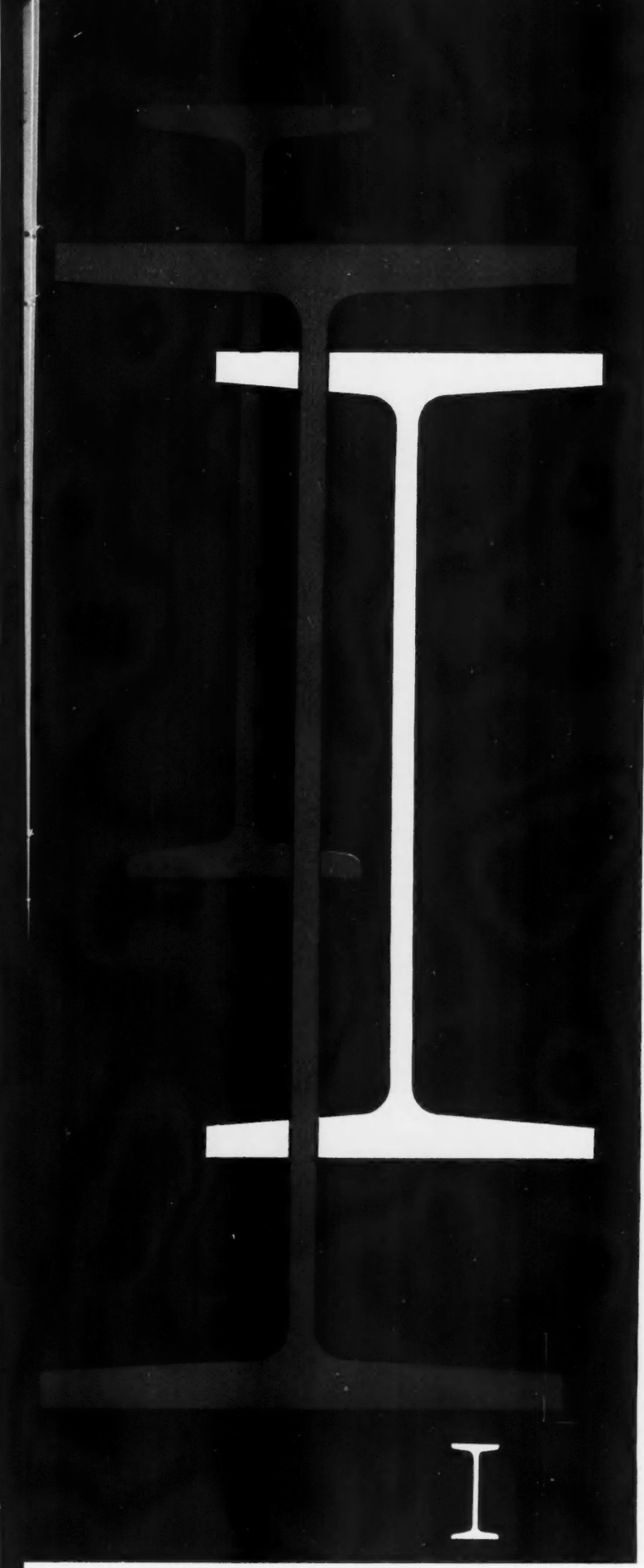
Nov. 14, 1958



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In addition to Universal Beams, the mill can roll British Standard sections.

The illustrations show interesting comparisons on the same scale.

The red beam is 24 in. by 7½ in., the largest of the British Standard range; the yellow beam is 24 in. by 12 in., hitherto the largest rolled in this country, but now available in three weights: 160, 120 and 100 lb. per foot; the blue beam is 36 in. by 16½ in., the largest in Europe, and is available in two weights, 260 and 230 lb. per foot.

Equally valuable are the new 'families of columns', which, like the beams, avoid the need for flange plating.

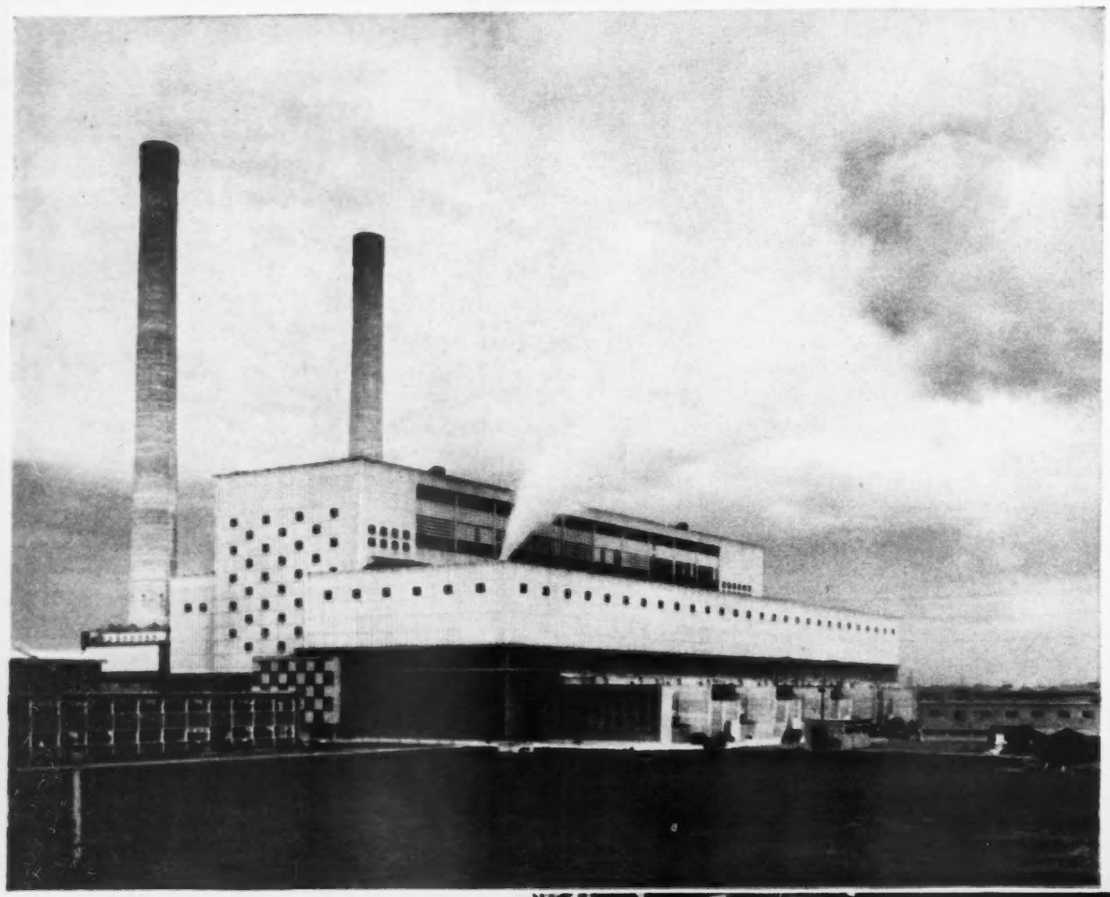
The little white section is the B.S. 3 by 1½ in. (4 lb.), to the same scale as the others and is the smallest I *section rolled by us.*

EARLY DELIVERY OF THE FULL RANGE OF SECTIONS

DORMAN LONG

THE ENGINEER
Nov. 14, 1958

CASTLE DONINGTON

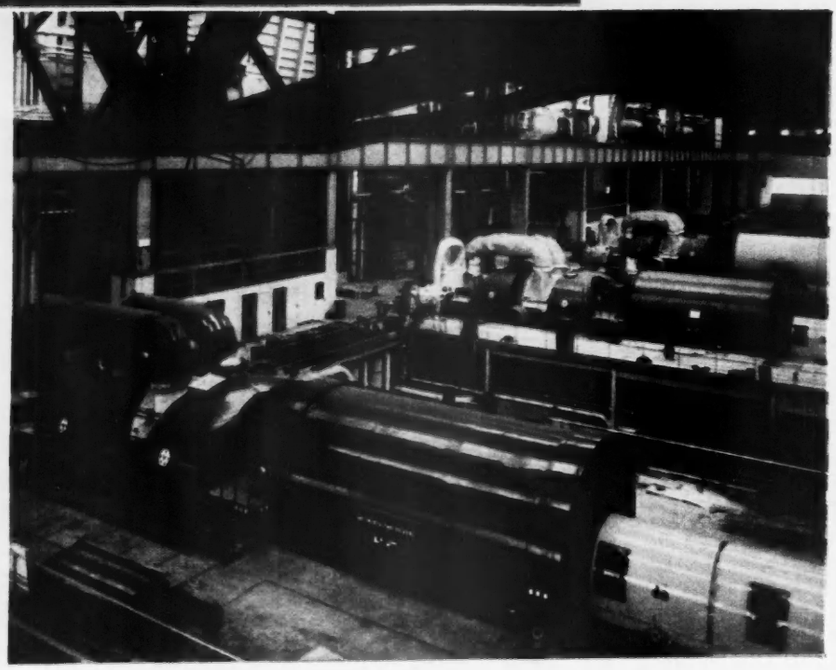


Castle Donington Power Station of the C.E.G.B., East Midlands Division.

Castle Donington Power Station was designed to house six 100 MW steam turbine-generators and their associated condensing plants and feed water heating and deaerating equipments, manufactured by Metropolitan-Vickers. The three units shown were the first 100 MW, 3,000 r.p.m units to be operated in Great Britain The turbines are of two-cylinder, close-coupled design, for operation with steam conditions at the turbine stop valve of 1500 psig, 1050°F. and exhausting to Metrovick condensers.

The 100 MW, 3 phase, 50 cycles, 13·8 kV hydrogen-cooled generators are direct-coupled to the steam turbines. The rotor windings are directly cooled by hydrogen circulating in contact with the copper.

The generators are directly connected to the Metrovick main step up transformers.



View of Turbine Hall during construction of the first three sets. Of the six sets ordered, five are installed. The sixth set has completed its test at works and is being shipped to site.

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"WELDING OF STEEL CASTINGS IN THE LIGHT OF MODERN PRACTICE"

A new booklet on this important subject has now been issued by the British Steel Founders' Association

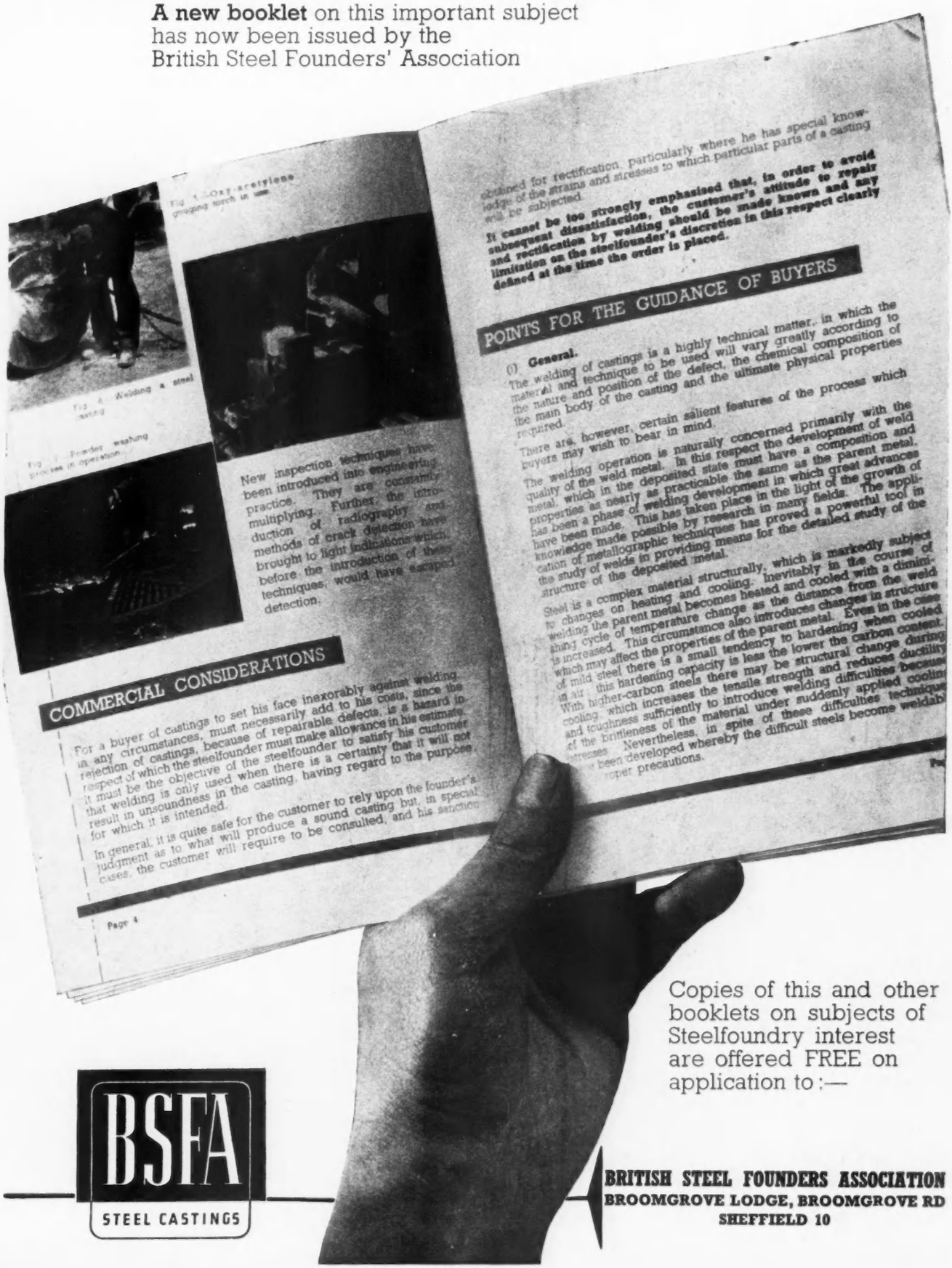
Fig. 1. Oxy-acetylene gouging torch in use.
Fig. 2. Welding a steel casting.
Fig. 3. Powder washing process in operation.
New inspection techniques have been introduced into engineering practice. They are constantly multiplying. Further the introduction of radiography and methods of crack detection have brought to light indications which, before the introduction of these techniques, would have escaped detection.
COMMERCIAL CONSIDERATIONS
For a buyer of castings to set his face inexorably against welding in any circumstances, must necessarily add to his costs, since the rejection of castings, because of repairable defects, is a hazard in respect of which the steelfounder must make allowance in his estimate. It must be the objective of the steelfounder to satisfy his customer that welding is only used when there is a certainty that it will not result in unsoundness in the casting, having regard to the purpose for which it is intended.
In general, it is quite safe for the customer to rely upon the founder's judgment as to what will produce a sound casting but, in special cases, the customer will require to be consulted, and his sanction
Page 4
obtained for rectification, particularly where he has special knowledge of the strains and stresses to which particular parts of a casting will be subjected.
It cannot be too strongly emphasised that, in order to avoid subsequent dissatisfaction, the customer's attitude to repair and rectification by welding should be made known and any limitation on the steelfounder's discretion in this respect clearly defined at the time the order is placed.
POINTS FOR THE GUIDANCE OF BUYERS
(1) General.
The welding of castings is a highly technical matter, in which the material and technique to be used will vary greatly according to the nature and position of the defect, the chemical composition of the main body of the casting and the ultimate physical properties required.
There are, however, certain salient features of the process which buyers may wish to bear in mind.
The welding operation is naturally concerned primarily with the quality of the weld metal. In this respect the development of weld metal, which in the deposited state must have a composition and properties as nearly as practicable the same as the parent metal, has been a phase of welding development in which great advances have been made. This has taken place in the light of the growth of knowledge made possible by research in many fields. The application of metallographic techniques has proved a powerful tool in the study of welds in providing means for the detailed study of the structure of the deposited metal.
Steel is a complex material structurally, which is markedly subject to changes on heating and cooling. Inevitably in the course of welding the parent metal becomes heated and cooled with a diminishing cycle of temperature change as the distance from the weld is increased. This circumstance also introduces changes in structure which may affect the properties of the parent metal. Even in the case of mild steel there is a small tendency to hardening when cooled in air, this hardening capacity is less the lower the carbon content. With higher-carbon steels there may be structural change during cooling which increases the tensile strength and reduces ductility and toughness sufficiently to introduce welding difficulties because of the brittleness of the material under suddenly applied cooling stresses. Nevertheless, in spite of these difficulties techniques have been developed whereby the difficult steels become weldable under proper precautions.

Copies of this and other booklets on subjects of Steelfoundry interest are offered FREE on application to:—

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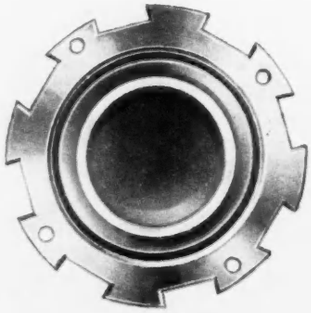

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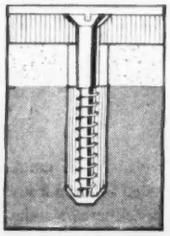
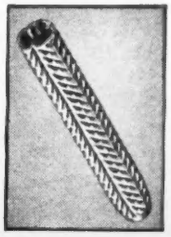
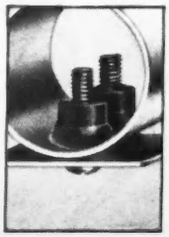
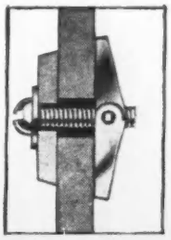
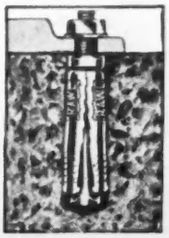

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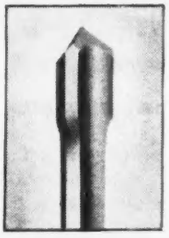

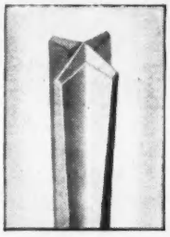
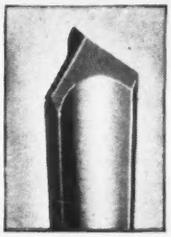
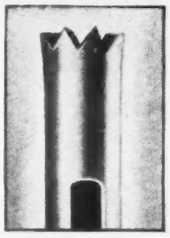

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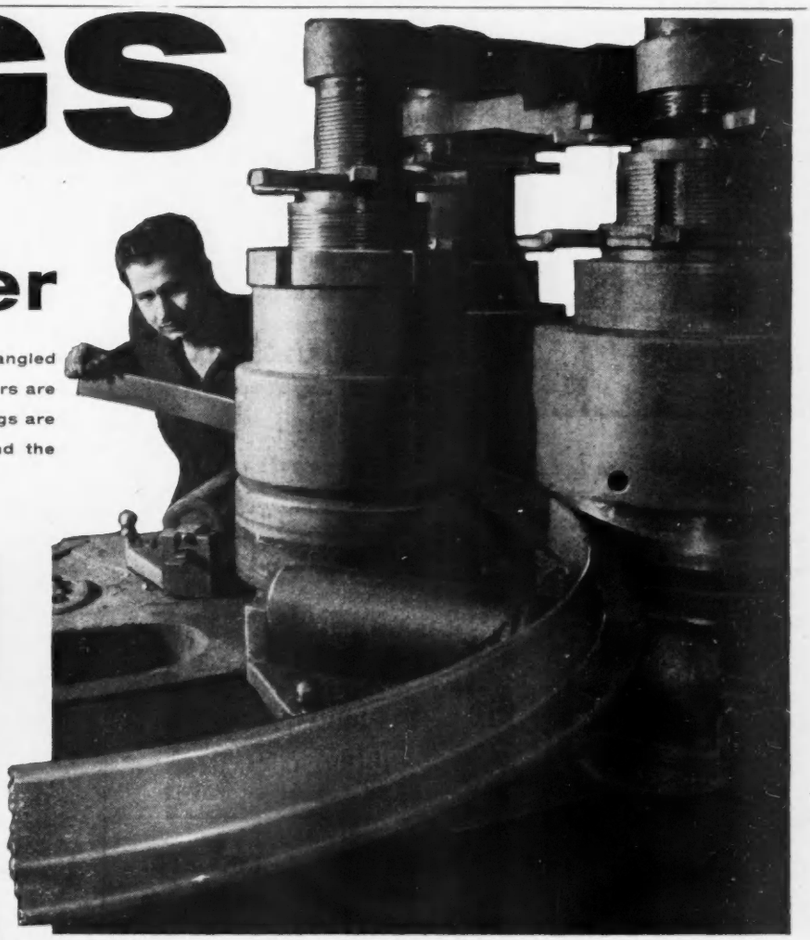

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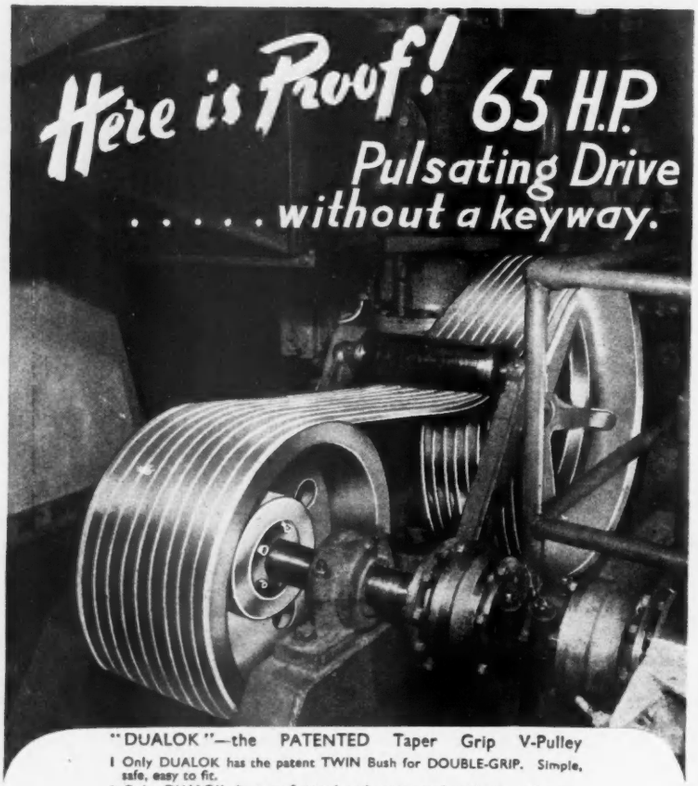

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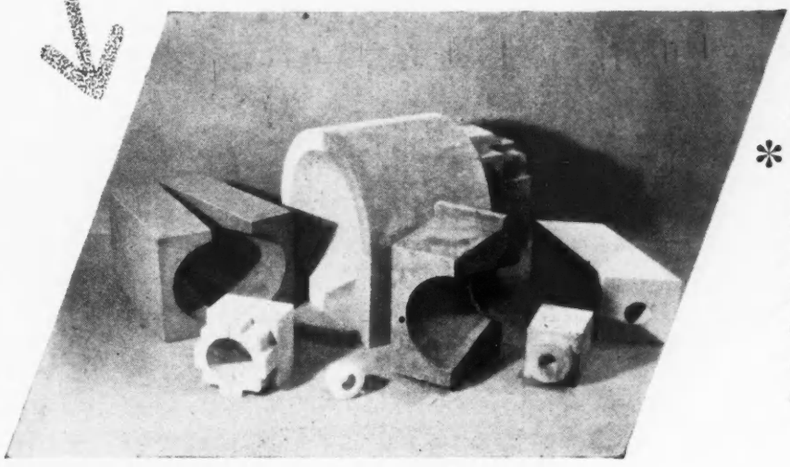

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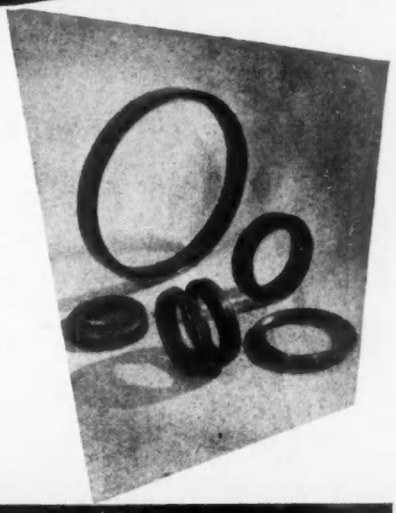

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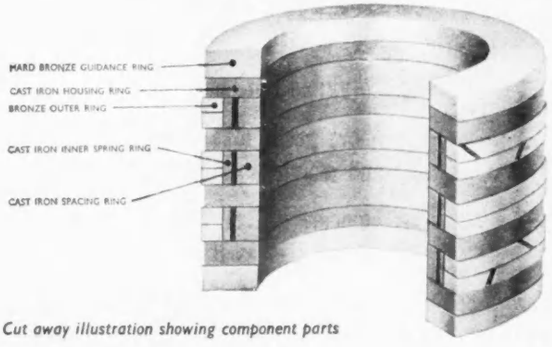

Cut away illustration showing component parts

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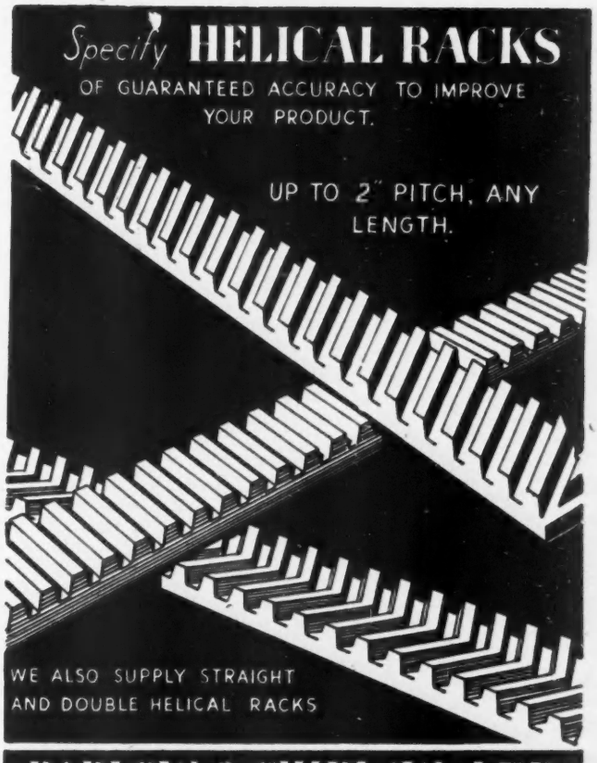
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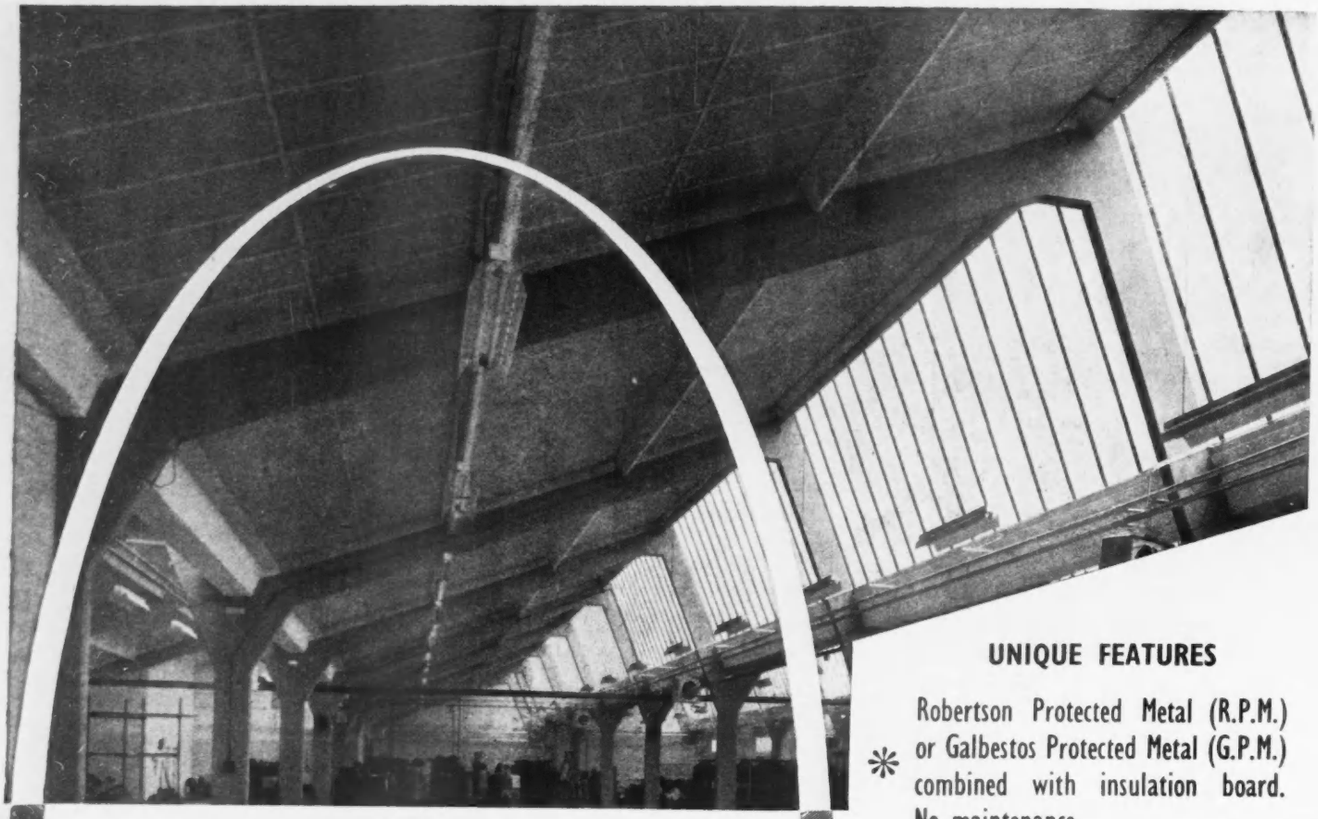

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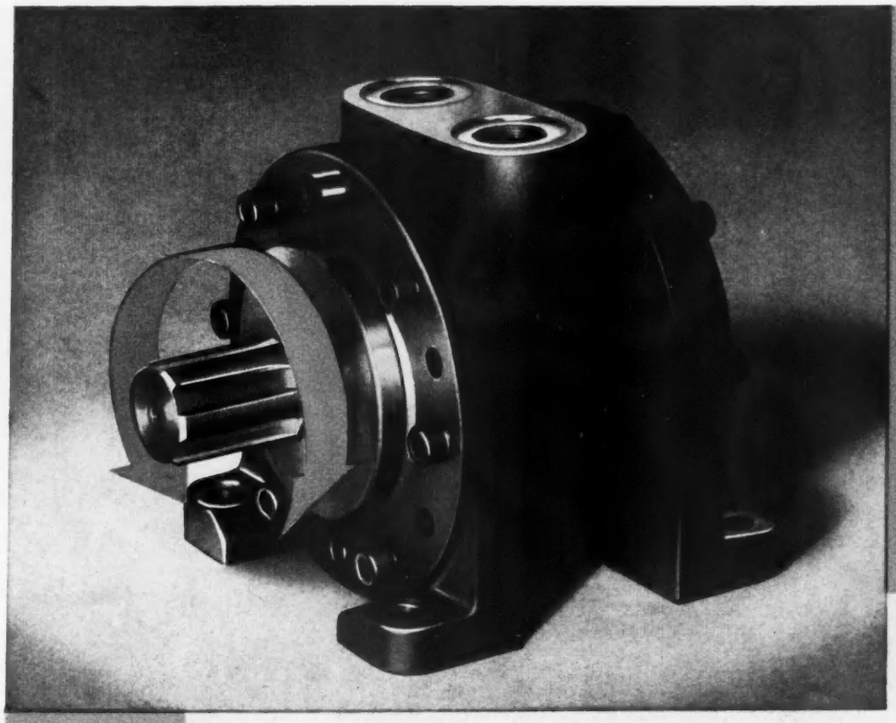

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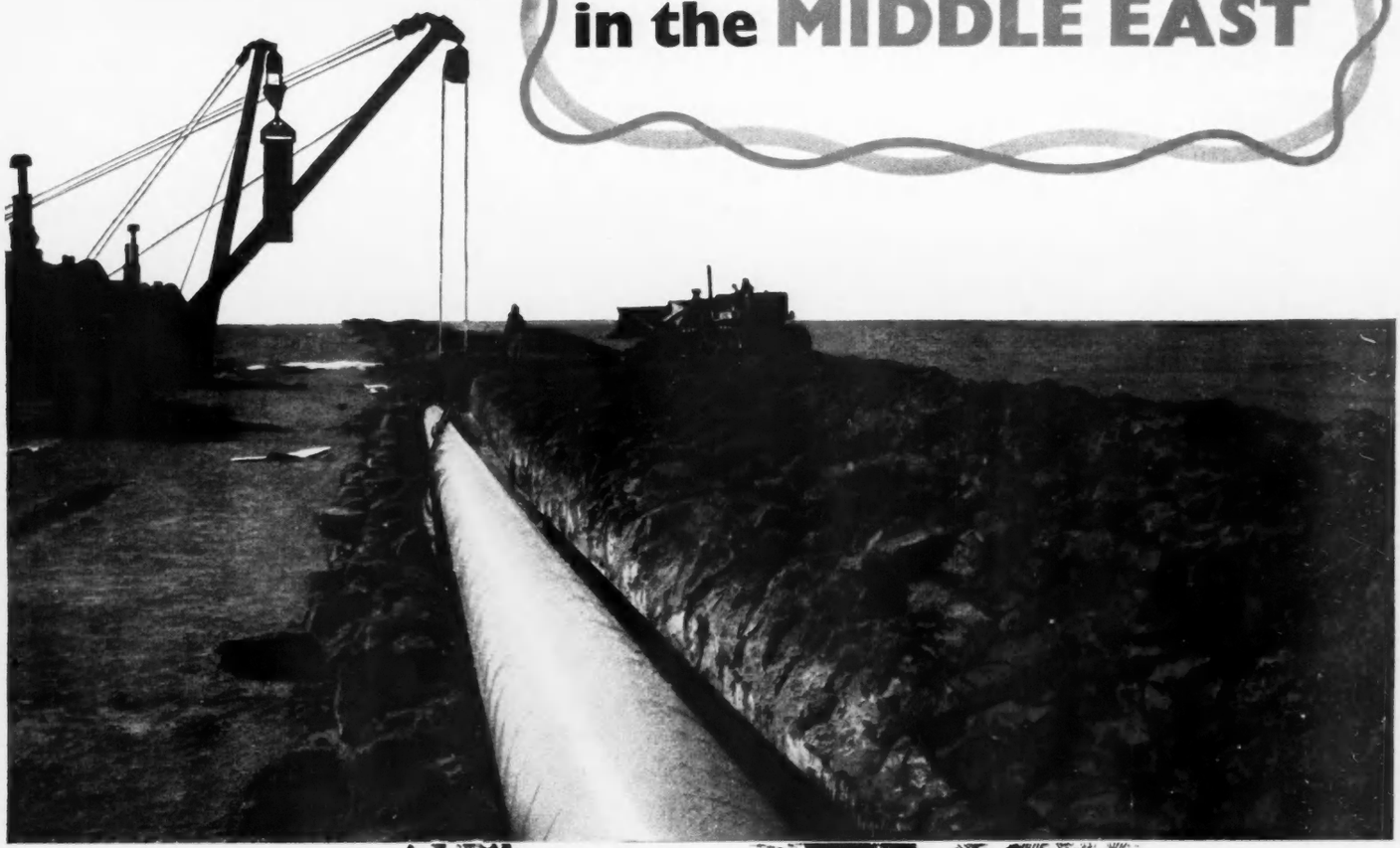

Illustration shows construction in progress on the Basrah Petroleum Company's 65-mile pipeline which now delivers oil from the Zubair and Rumaila fields to the terminal at Fao at the mouth of the Shatt-el-Arab River.

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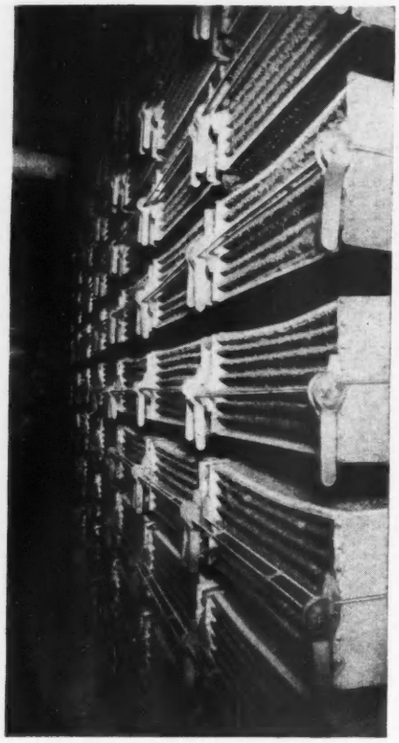

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The K.600 KOMPAK, when tested in accordance with BRITISH STANDARD 2831, and using the highly penetrating test dusts as specified, showed the following efficiency:—

Against Aloxite 50—95% **Against Aloxite 225—93%**

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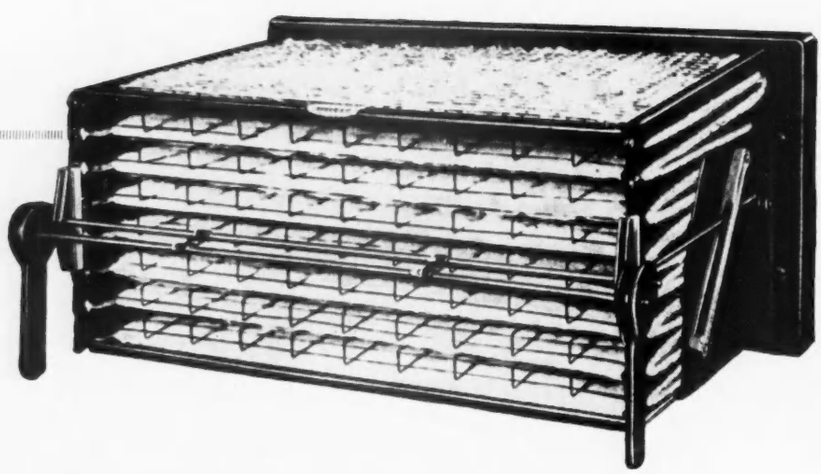

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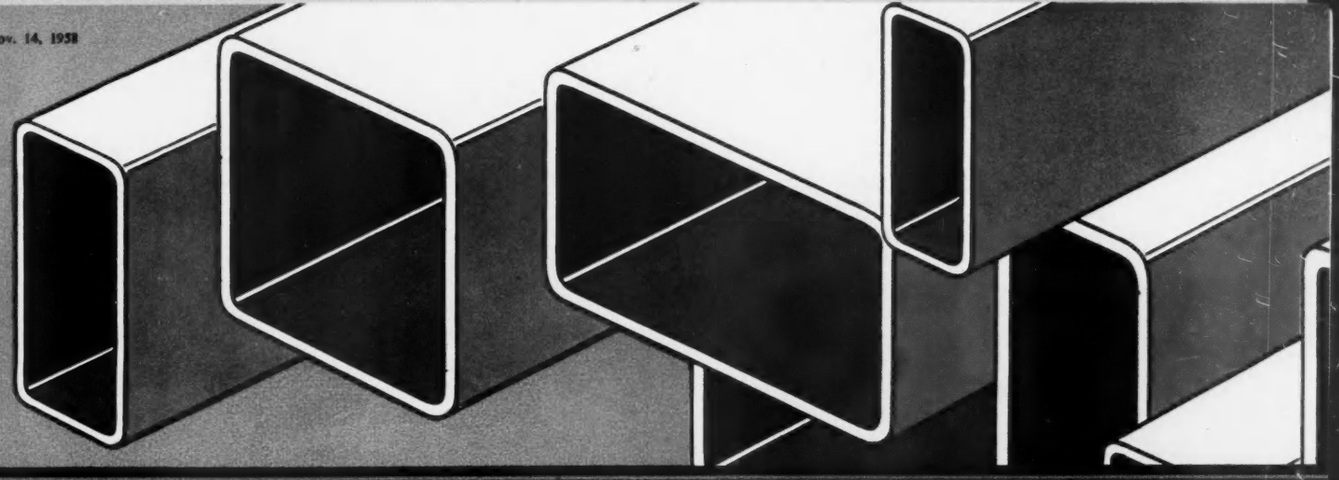
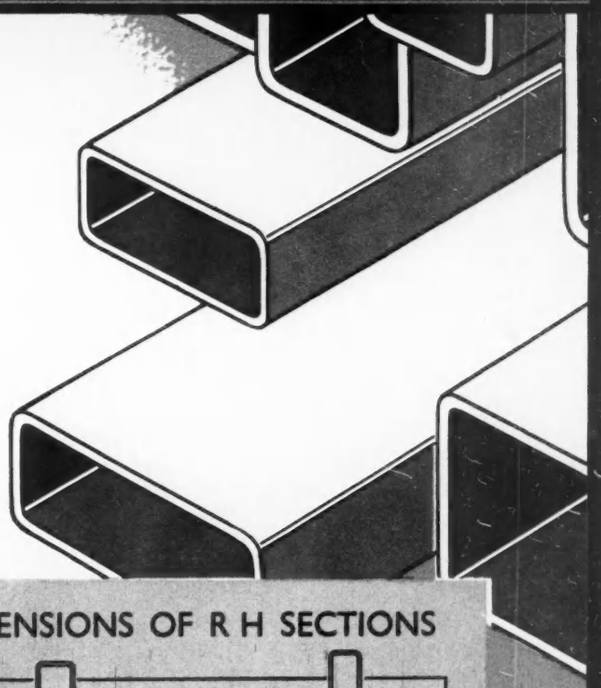


A further advance in tubular steelwork:



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Welded tubular construction has made great progress in recent years in its applications to mechanical handling and similar equipment. A further step forward is being made with our new range of hot-rolled Rectangular Hollow Sections. These have been developed in conjunction with our subsidiary, Tubewrights Ltd., who are acknowledged specialists in tubular construction.

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16 standard sizes of hot-rolled R.H. Sections are available, each in two thicknesses; they range from $1\frac{3}{8}$" square to 5" x $2\frac{1}{8}$". Several sections have matching dimensions and this is of advantage in the production of neat fabricated structures. The 1·90" square R.H.S., for example, matches the short sides of a 3·68" by 1·90" R.H.S.; these matching dimensions are made clear in our pamphlet, and in the accompanying table.

DIMENSIONS OF R H SECTIONS

INCHES	S.W.G	INCHES	S.W.G
1·36 x 1·36;	11g, 10g	2·44 x 1·36;	11g, 9g
1·90 x 1·90;	11g, 9g	3·17 x 1·59;	10g, 9g
2·125 x 2·125;	10g, 9g	3·68 x 1·90;	10g, 8g
2·38 x 2·38;	10g, 9g	4·76 x 2·38;	9g, 7g
2·50 x 2·50;	10g, 8g	1·90 x ·82;	11g, 10g
2·79 x 2·79;	10g, 8g	2·79 x 1·01;	11g, 9g
3·57 x 3·57;	9g, 7g	3·40 x 1·36;	10g, 9g
MATCHING DIMENSIONS ARE SHOWN IN HEAVY TYPE		3·99 x 1·59;	10g, 8g
		5·01 x 2·125;	9g, 7g

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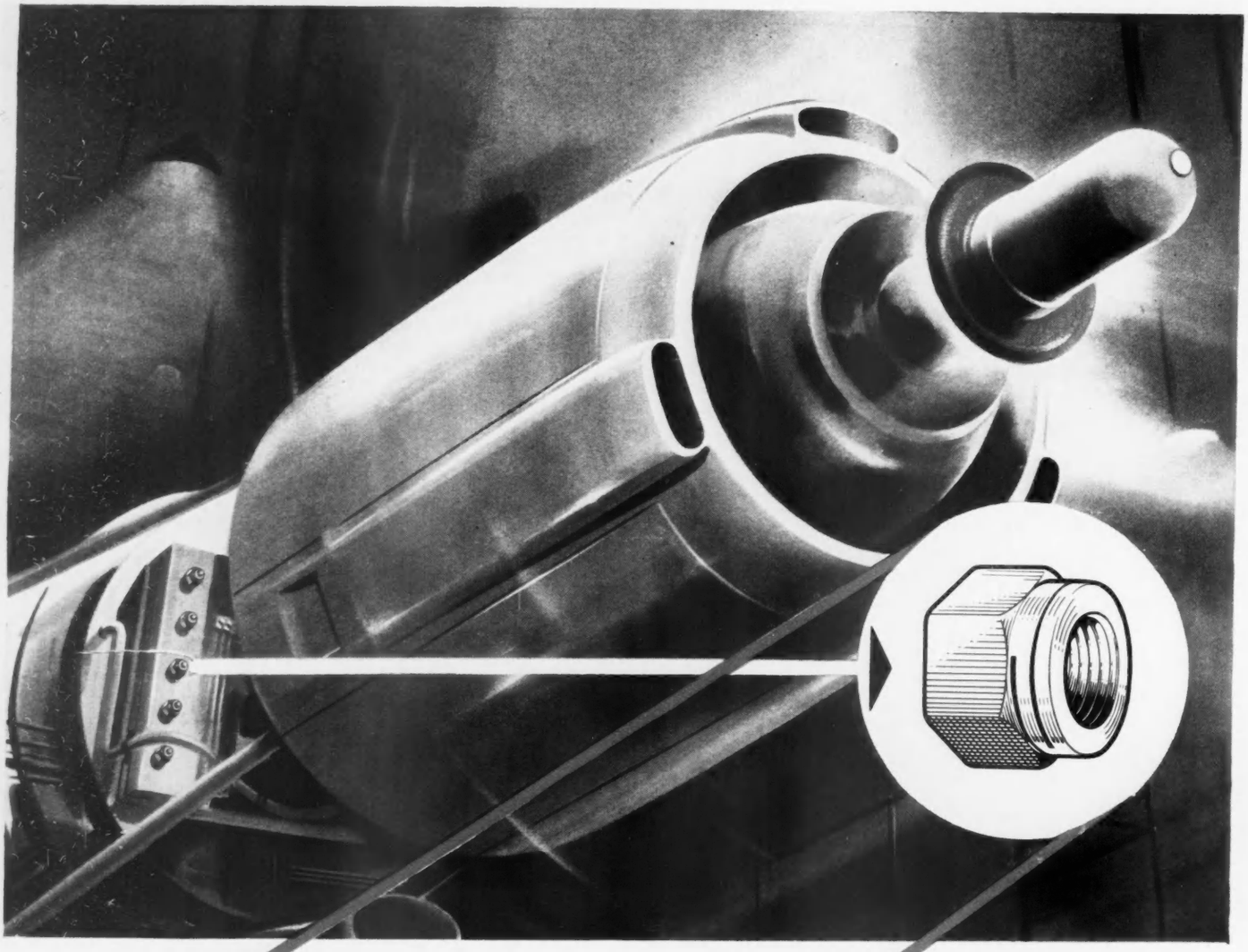

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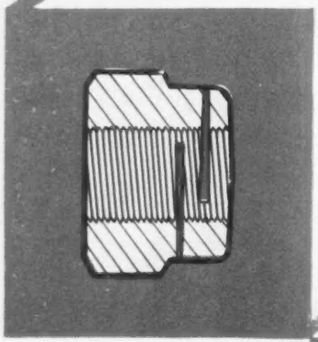

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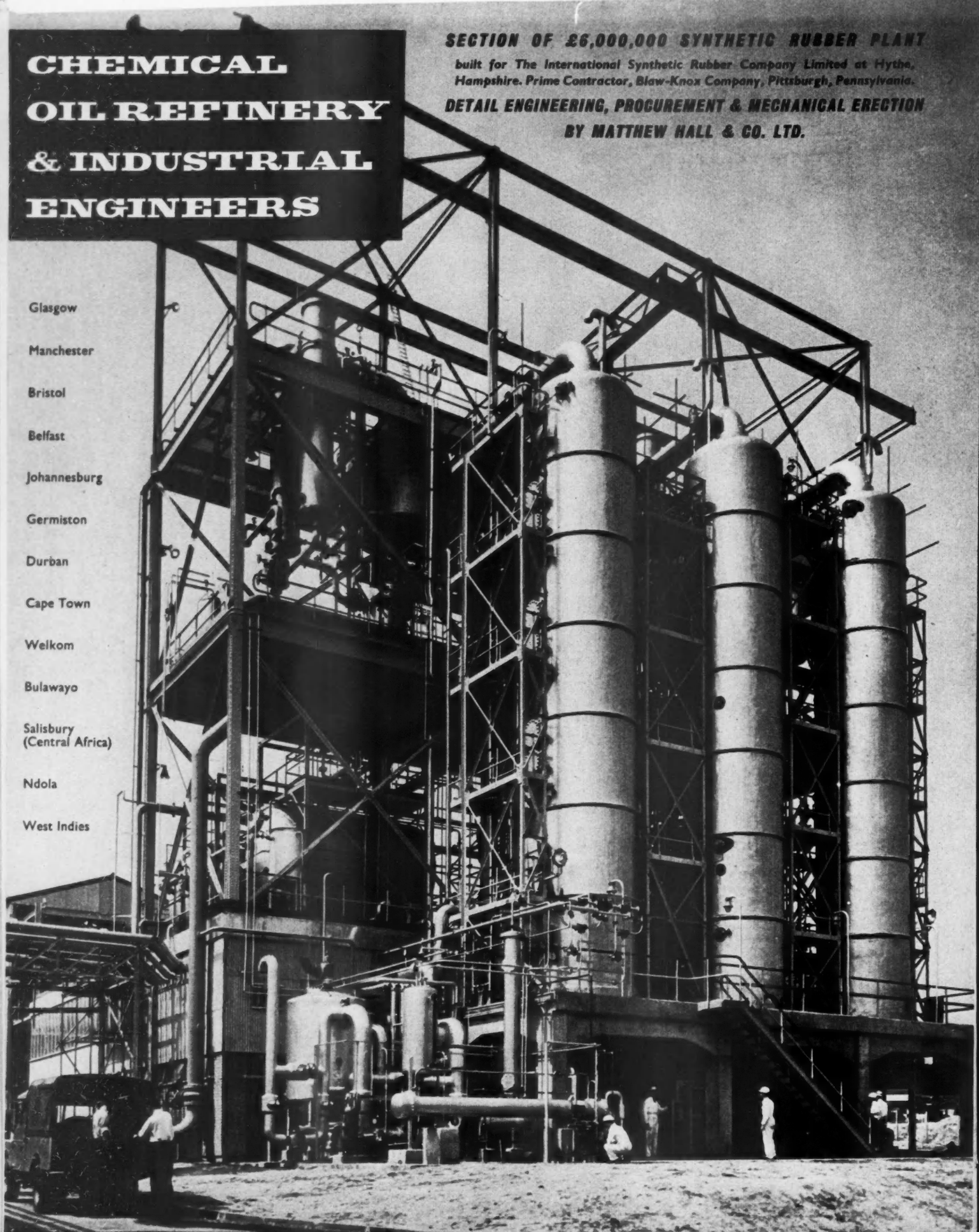

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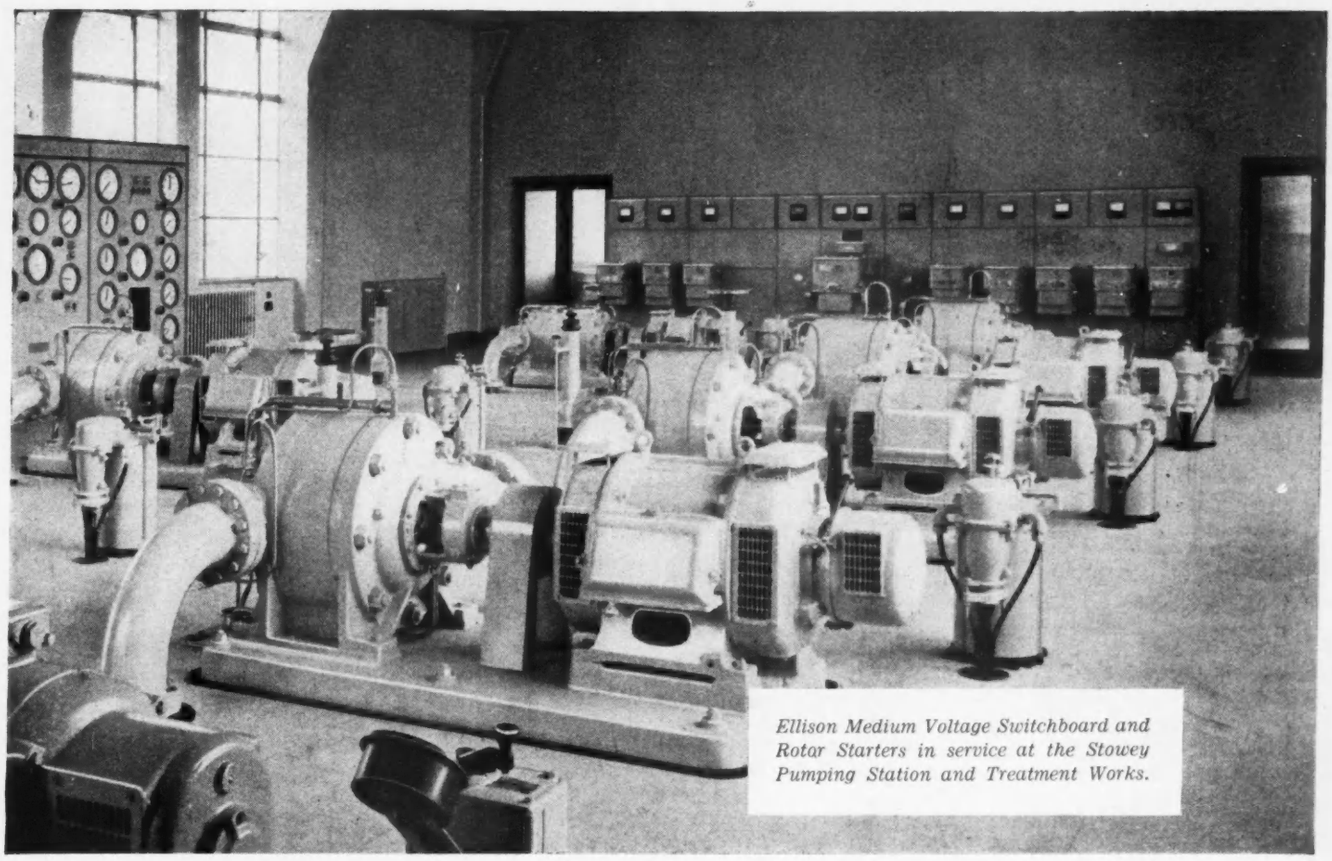

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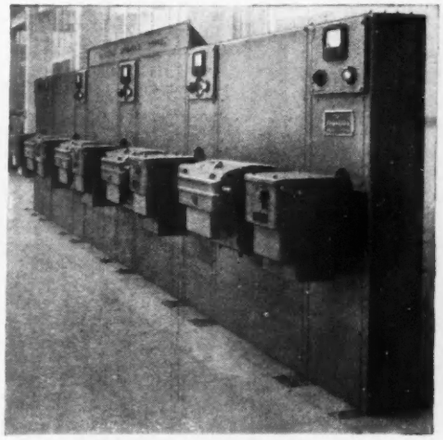

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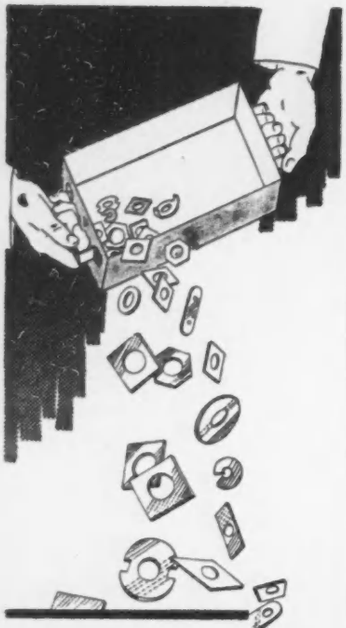

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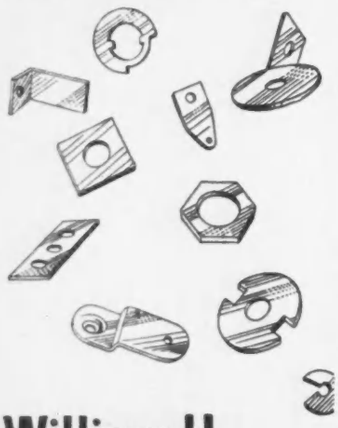

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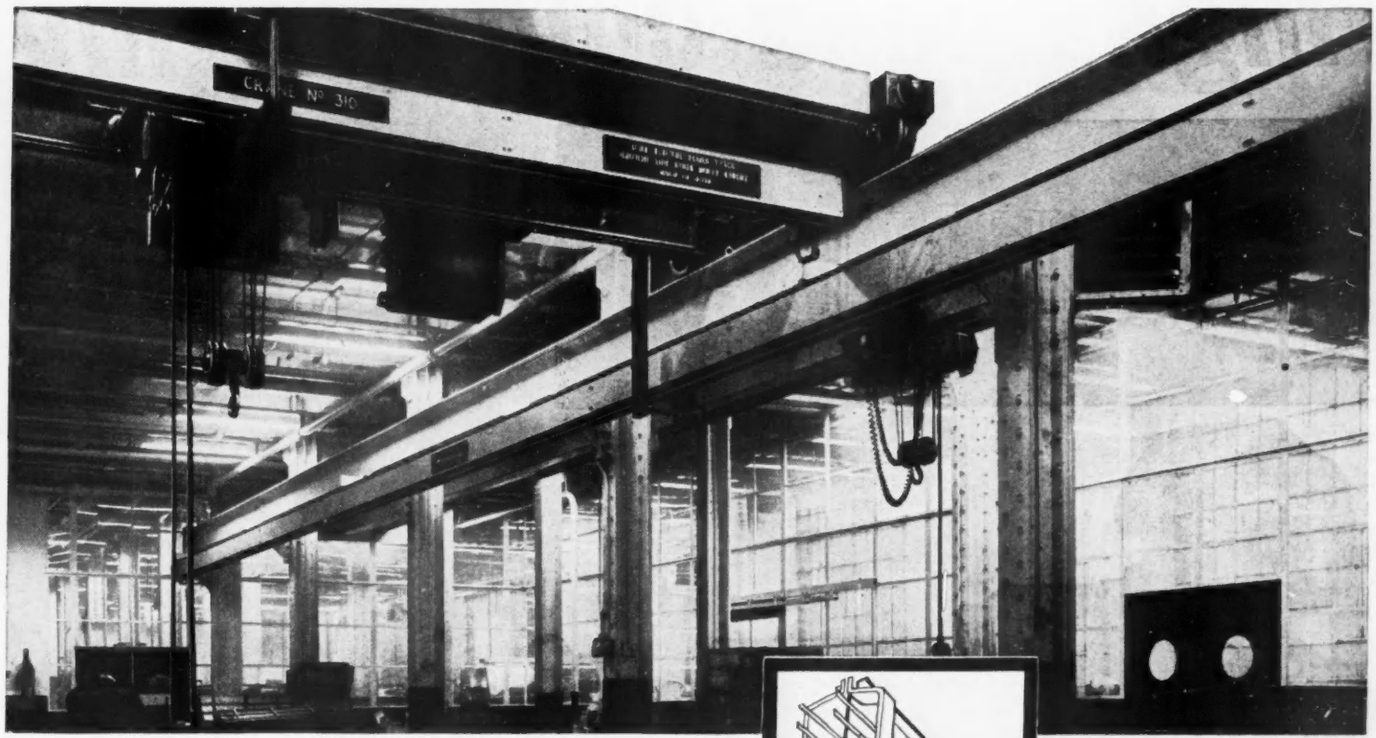

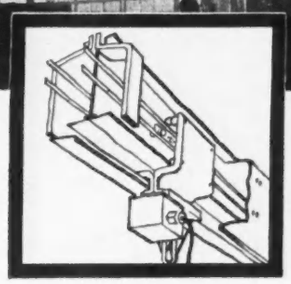

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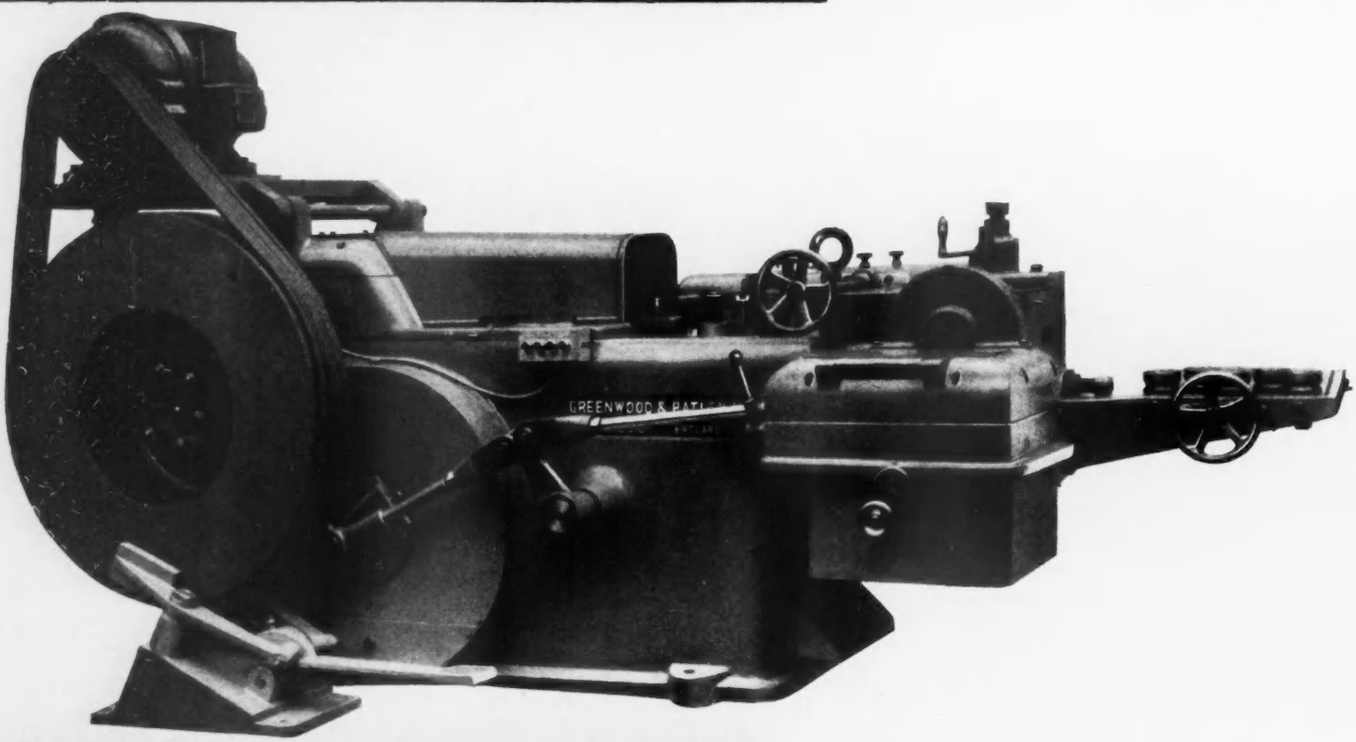

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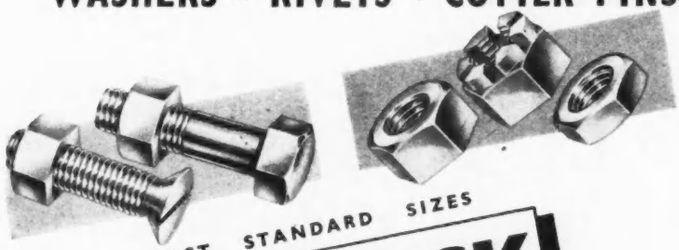

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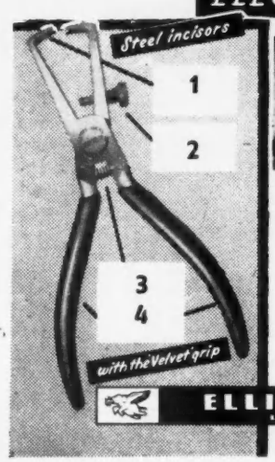

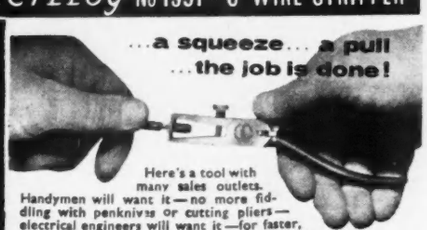

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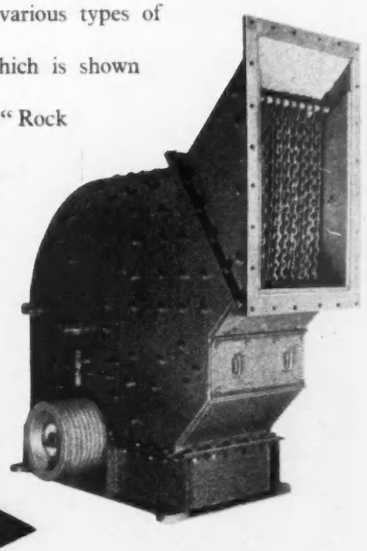

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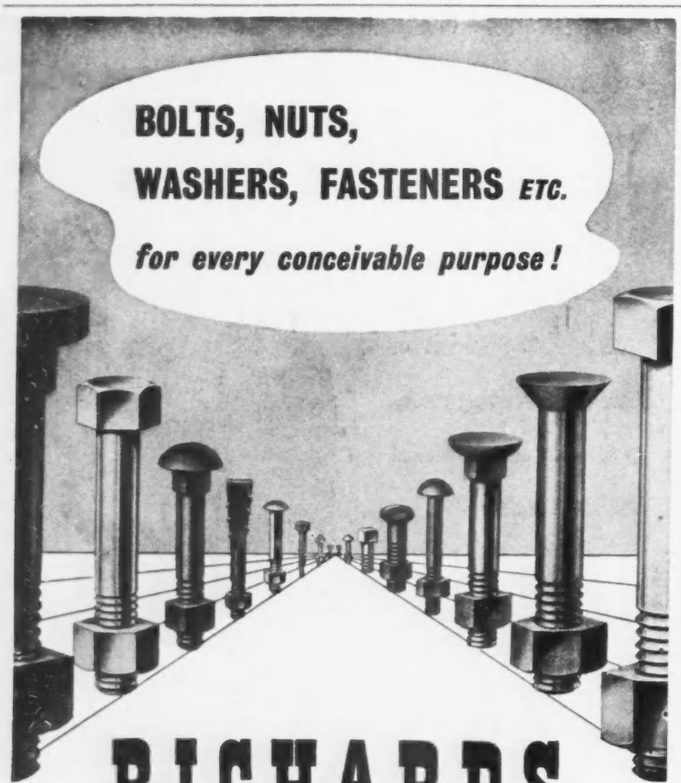

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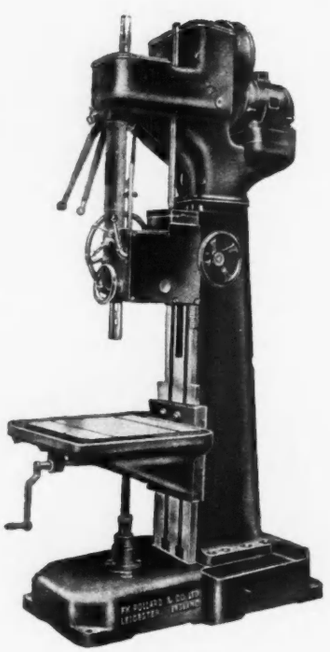

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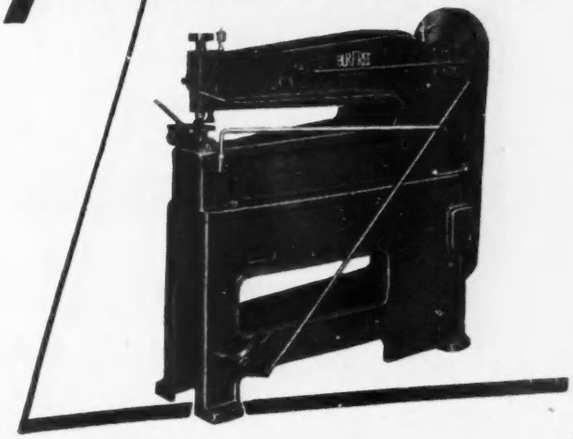

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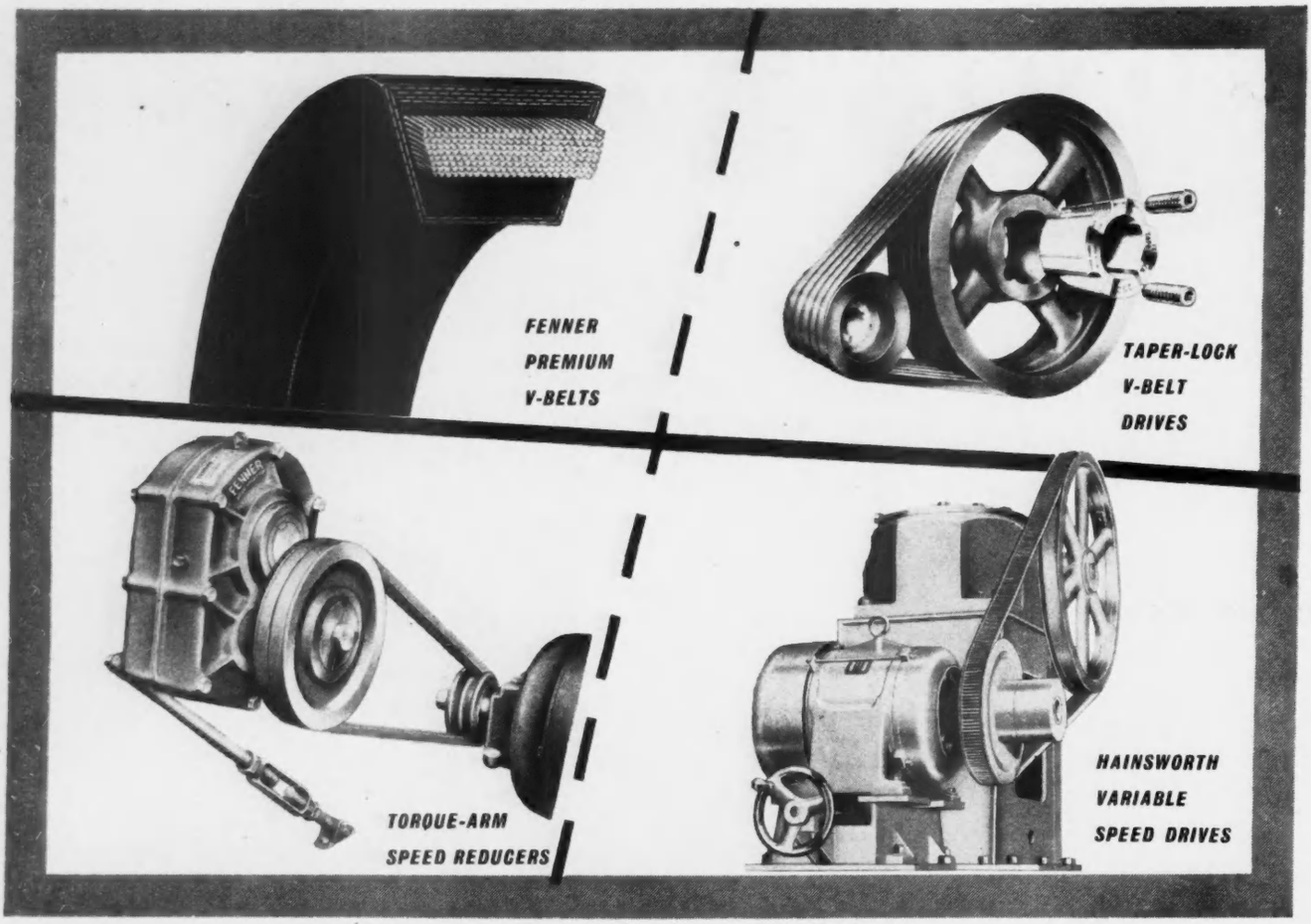

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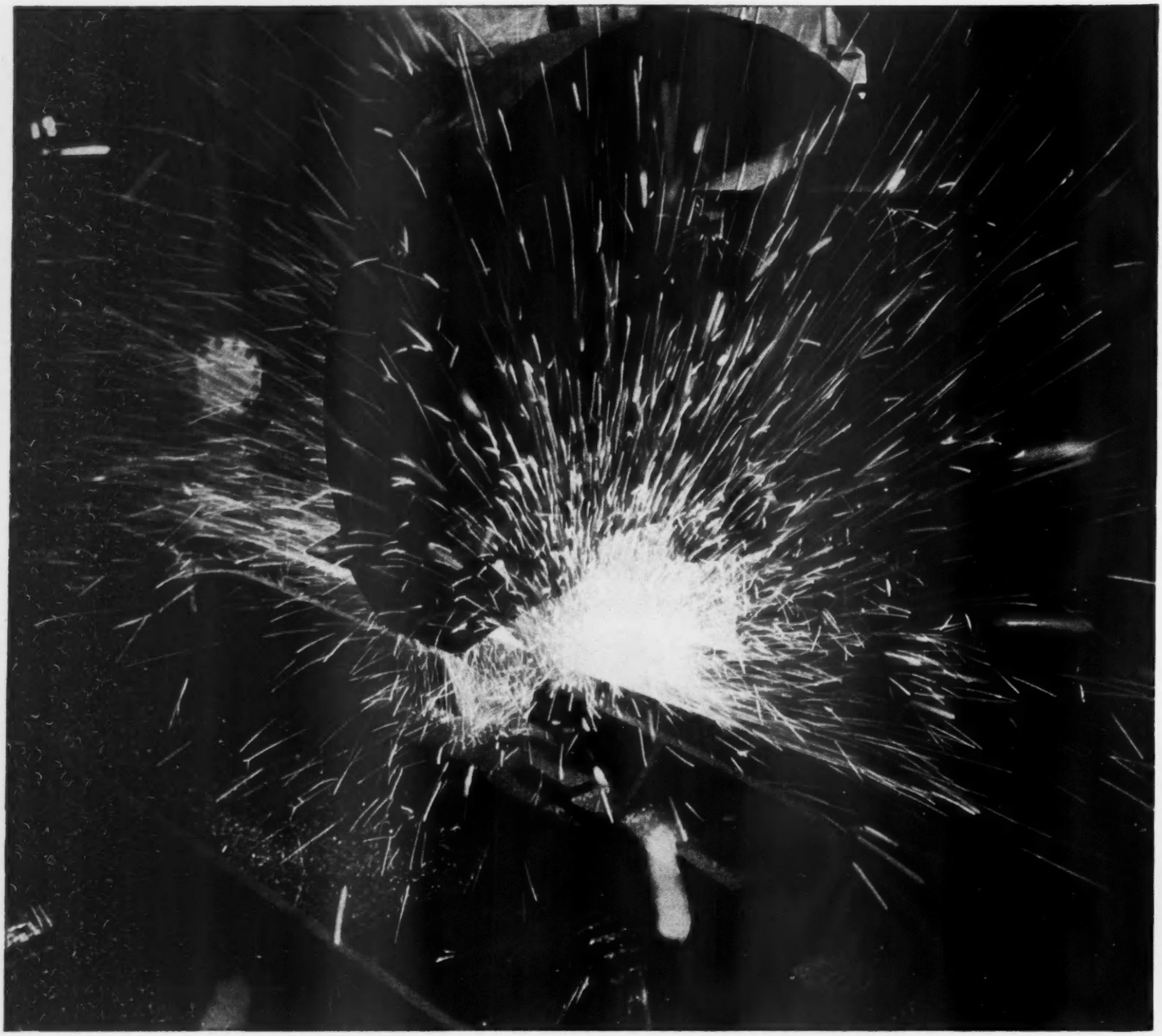

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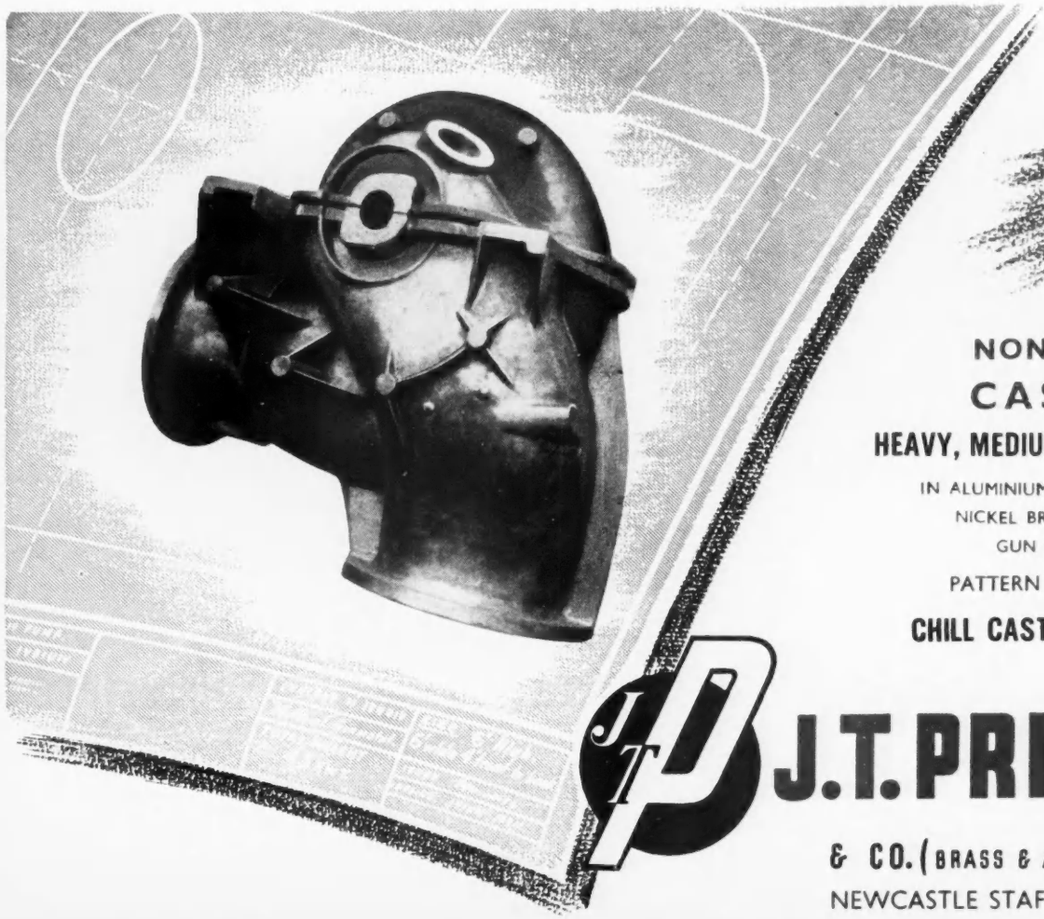

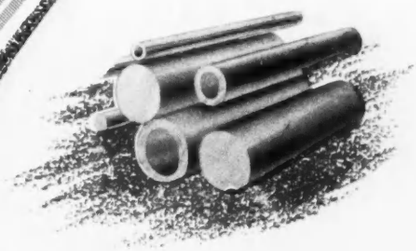

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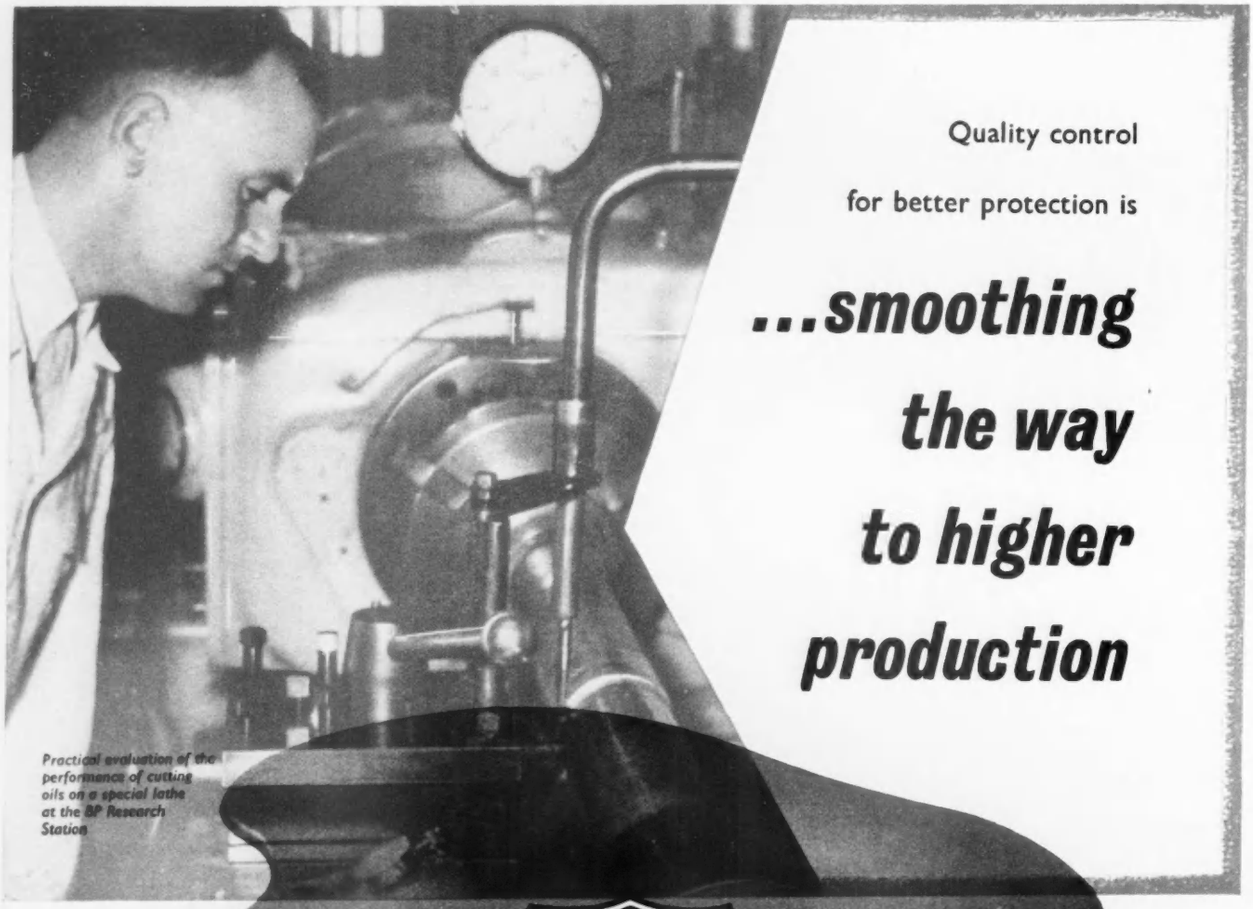

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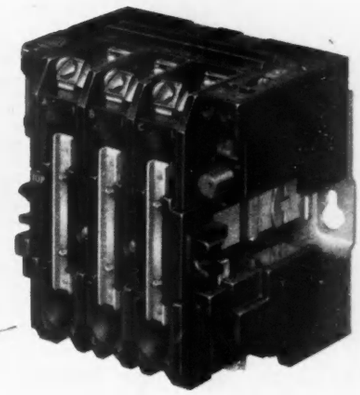
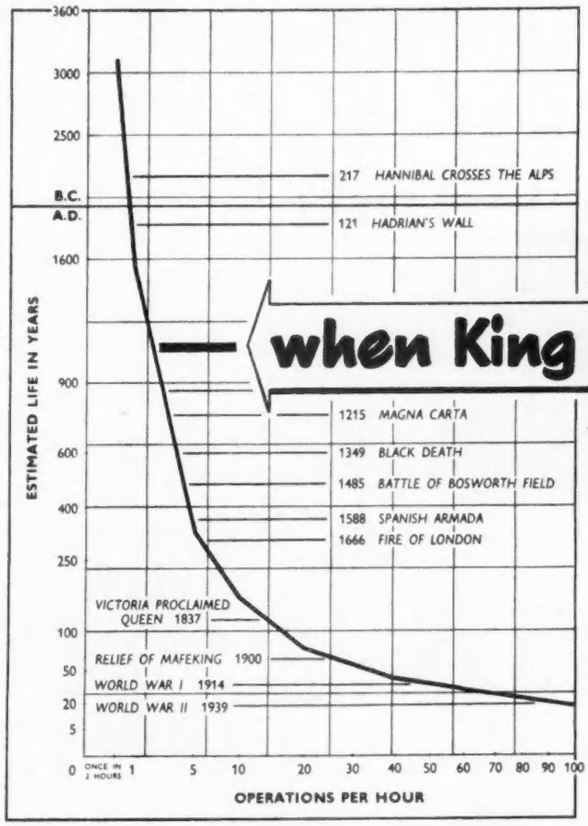
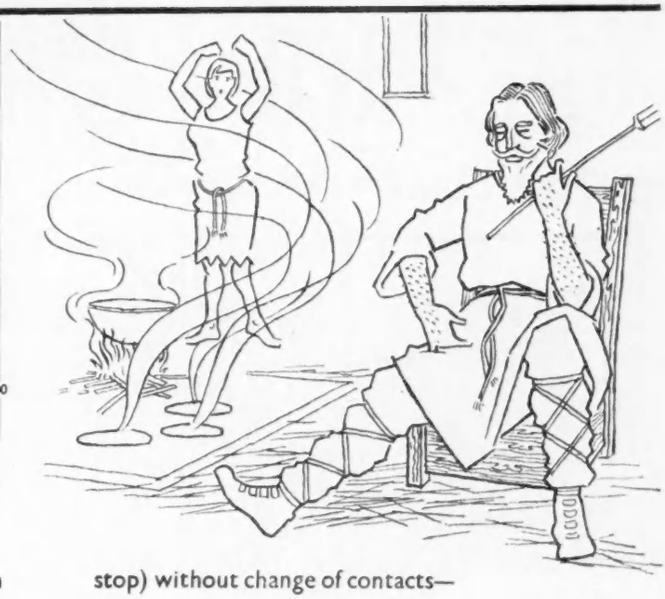




GRAPH SHOWING TIME TAKEN IN YEARS RELATED TO 4,100,000 OPERATIONS PERFORMED BY CRABTREE TYPE B-15 CONTACTOR (BASED ON A 50-HOUR WEEK AND A 52-WEEK YEAR)

when King Alfred burnt the cakes



Tests are now proceeding in which Crabtree Type B-15 starters are being used for repeatedly stopping and starting motors. To date, the starters have given the following operations (start and stop) without change of contacts—

(a) Controlling a 5 h.p. motor: 4,500,000 operations;

(b) Controlling a 1 h.p. motor: 4,500,000 operations;

These tests are continuing.

The contacts would now need inspection

Type B-15 contacts, on actual motor-load life tests, have already achieved 4,500,000 operations (start and stop) and are still giving satisfactory service.

J. A. CRABTREE & CO. LTD., LINCOLN WORKS, WALSALL, STAFFS.

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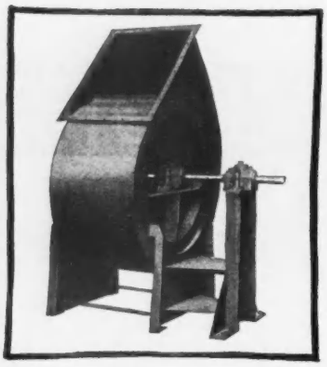
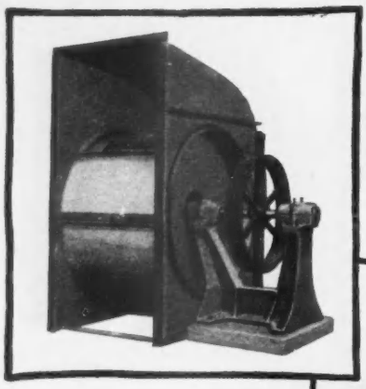
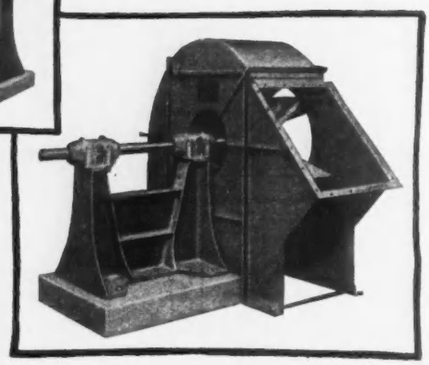


SLOW SPEED MULTIVANE FAN (Intermediate size).

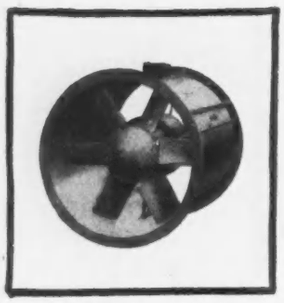


SLOW SPEED MULTIVANE FAN (Large size).

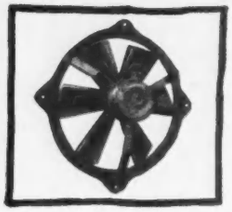
Air ways are our ways



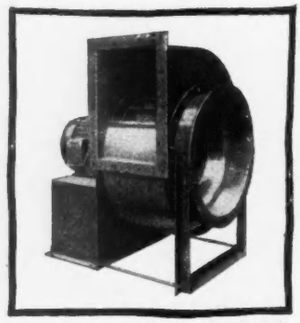
PADDLE BLADE FAN.



AXIAL FLOW FAN.



PROPELLER FAN.



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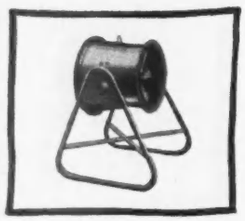

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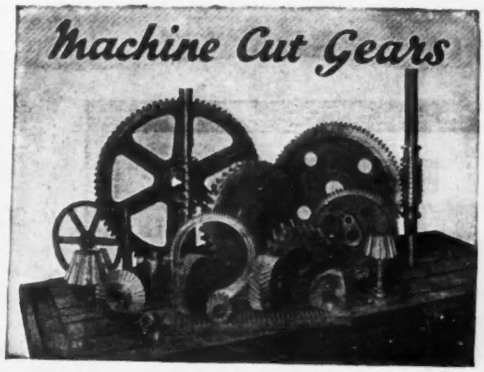

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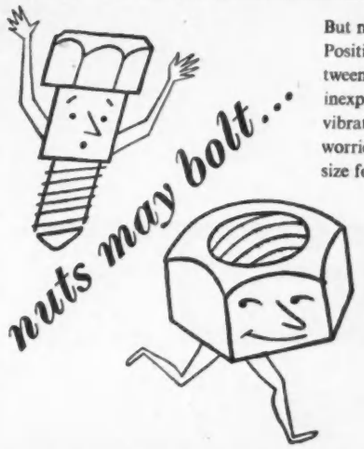

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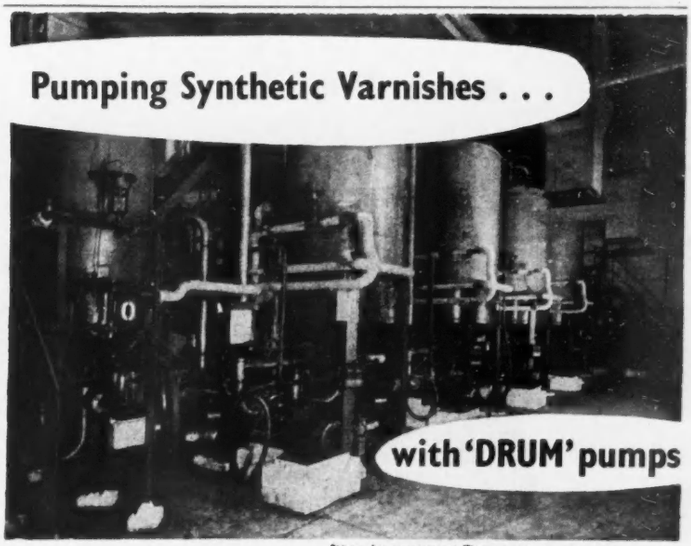

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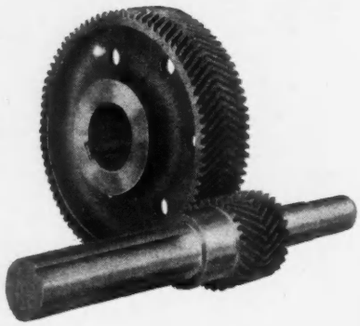

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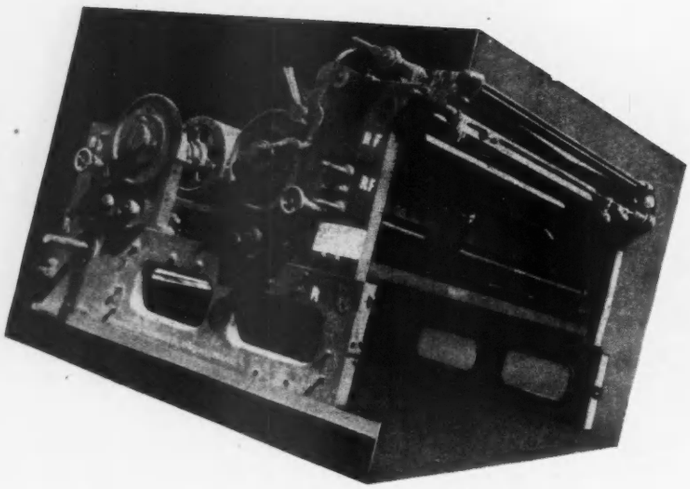

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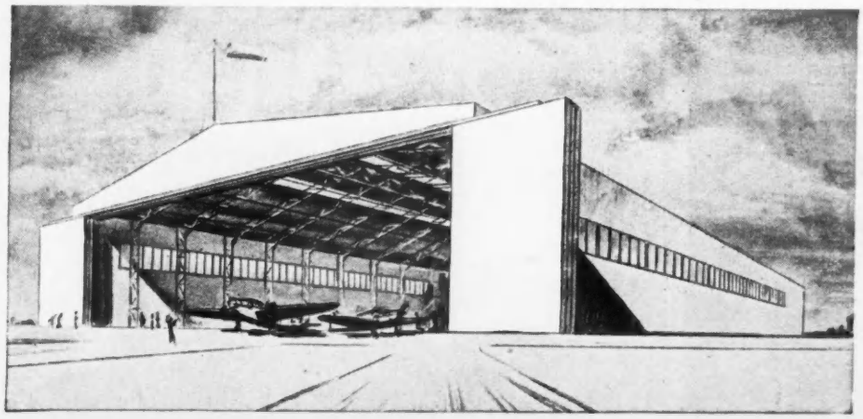

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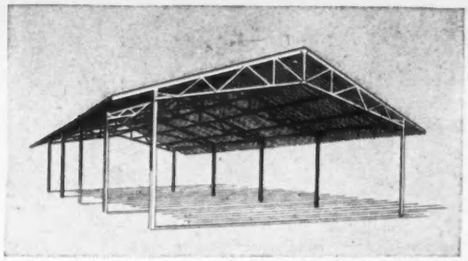

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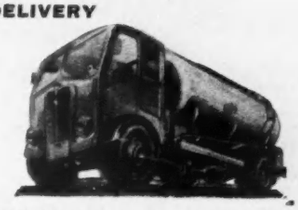

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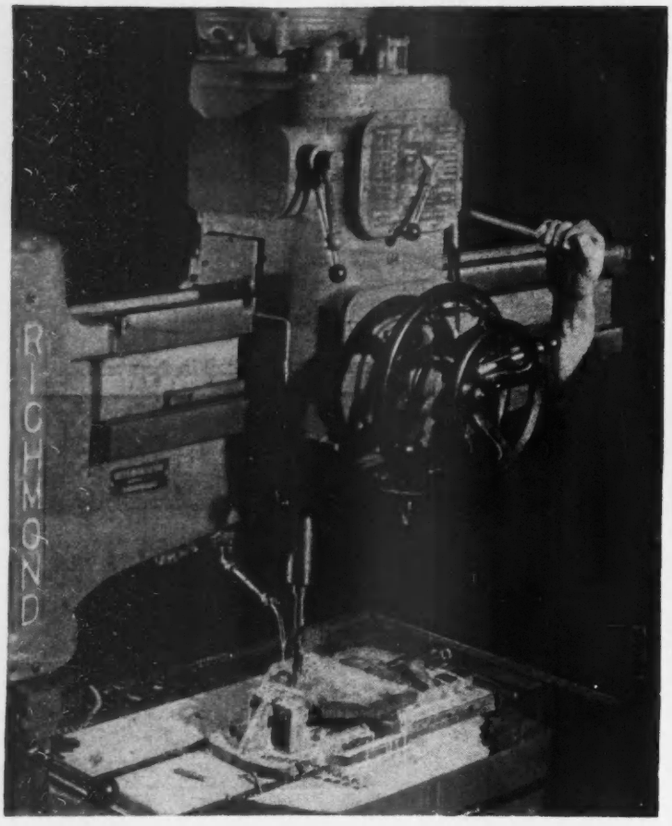

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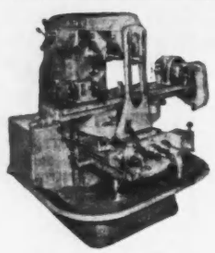

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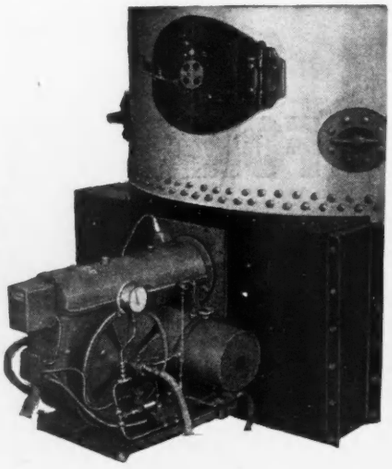

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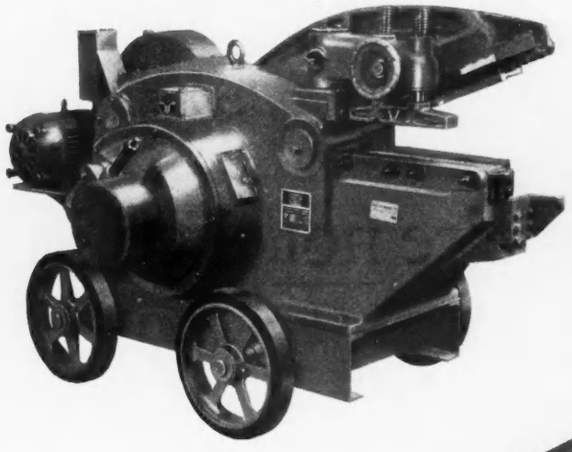

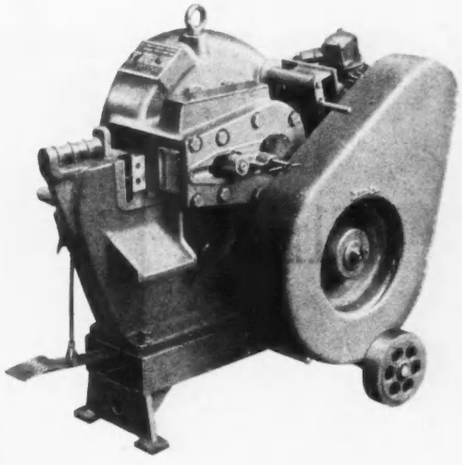

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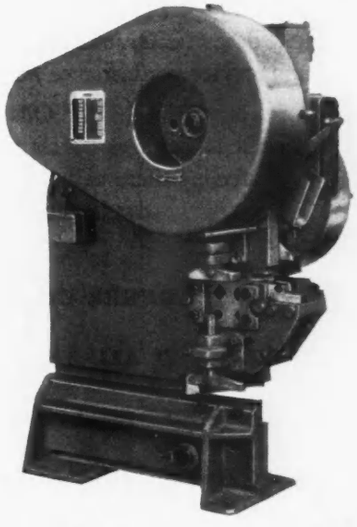

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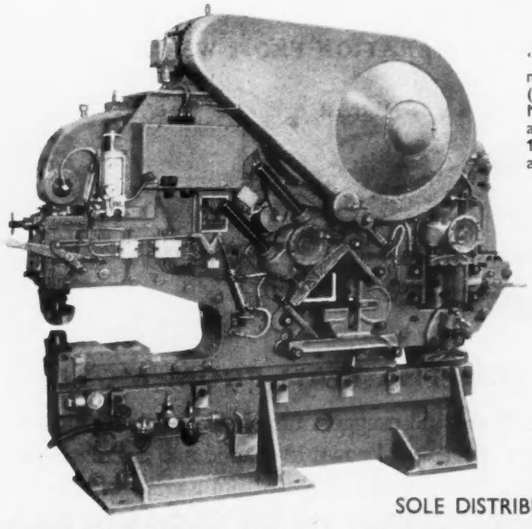

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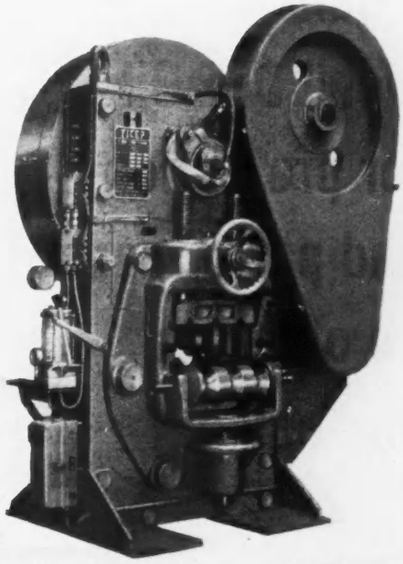

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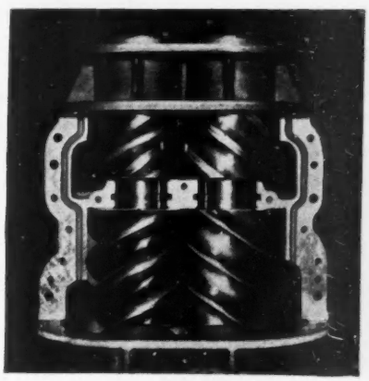
- This Compressor—based on a Swedish invention—is completely different in design from conventional rotary types.
- After extensive field tests Atlas Copco Twin-Air Portables were put into quantity production earlier this year and were first exhibited at the St. Eriks Fair in Stockholm last August.
- These Portable machines embody all the know-how gained from two years operating experience with Twin-Air Stationary Compressors installed in mines and industrial plants.
- The Twin-Air has no wearing parts in the two oil-flooded compression chambers, with the result that maintenance and overhauls are kept to a minimum.
- With the Twin-Air you get an overall operating efficiency which only a two stage machine can give.
- The Rotary Screw design guarantees a smooth air-flow, free from surging characteristics.
- The first models in this new range are machines of 390 c.f.m. and 630 c.f.m. Both 100% air-cooled, diesel-powered units.



The main components of the Twin-Air Compressor are two screws which intermesh without metallic contact.

PUBLIC WORKS EXHIBITION, OLYMPIA, LONDON, NOVEMBER 10th-15th, 1958

Atlas Copco PUTS COMPRESSED AIR TO WORK FOR THE WORLD

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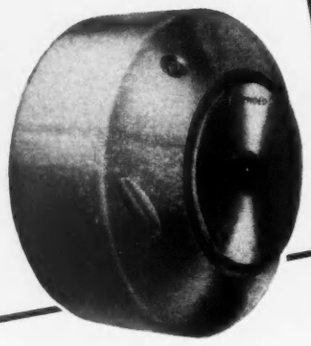
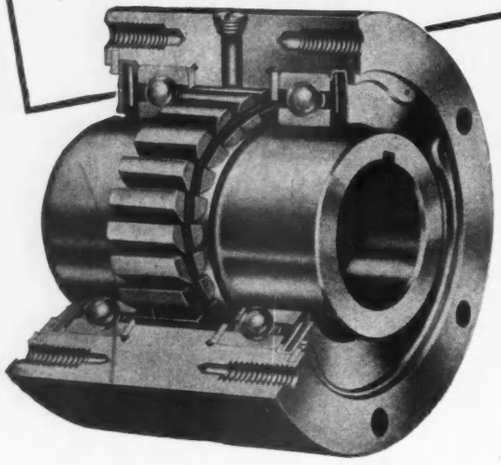


CHAIN COUPLINGS up to 1500 h.p.



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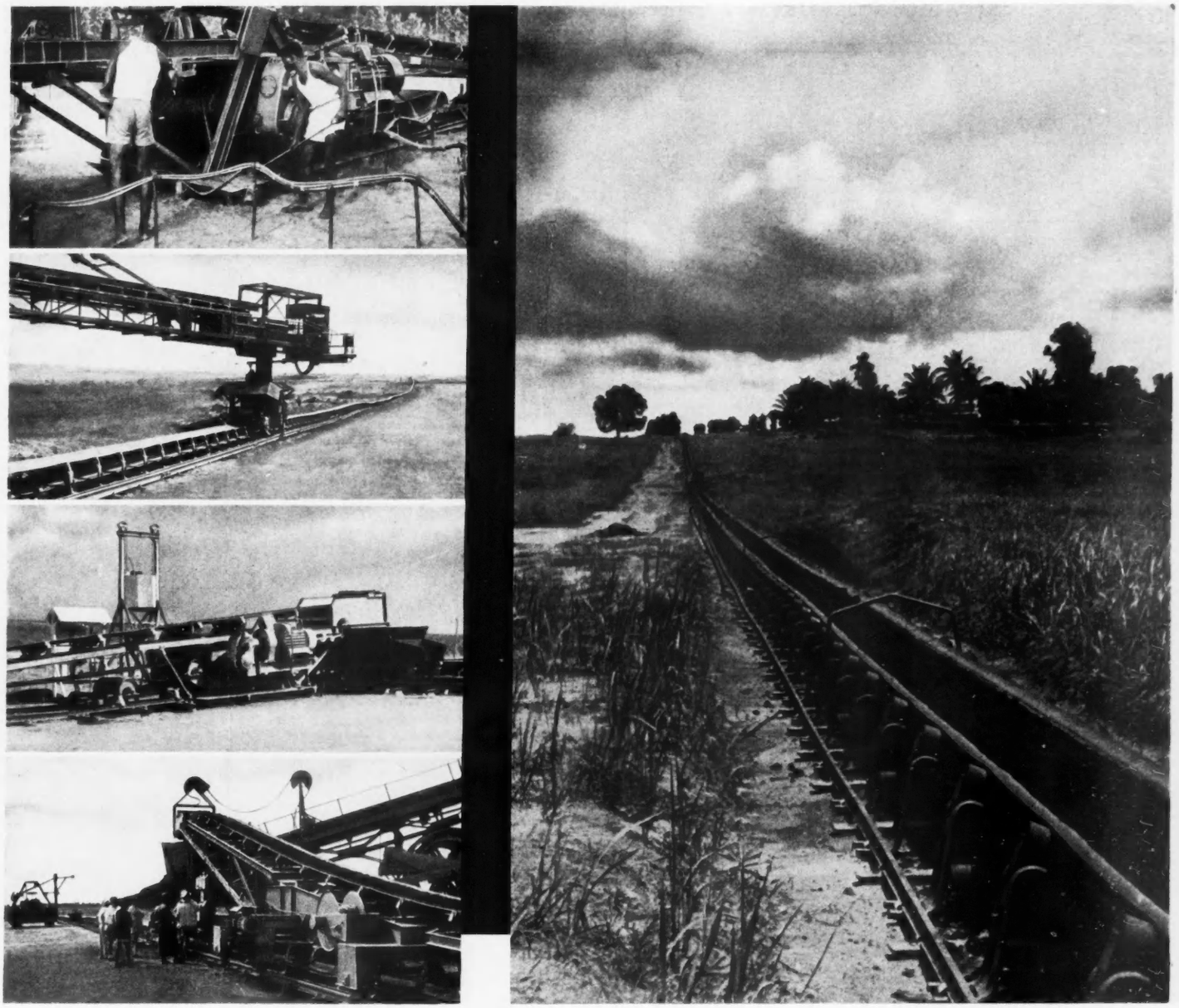

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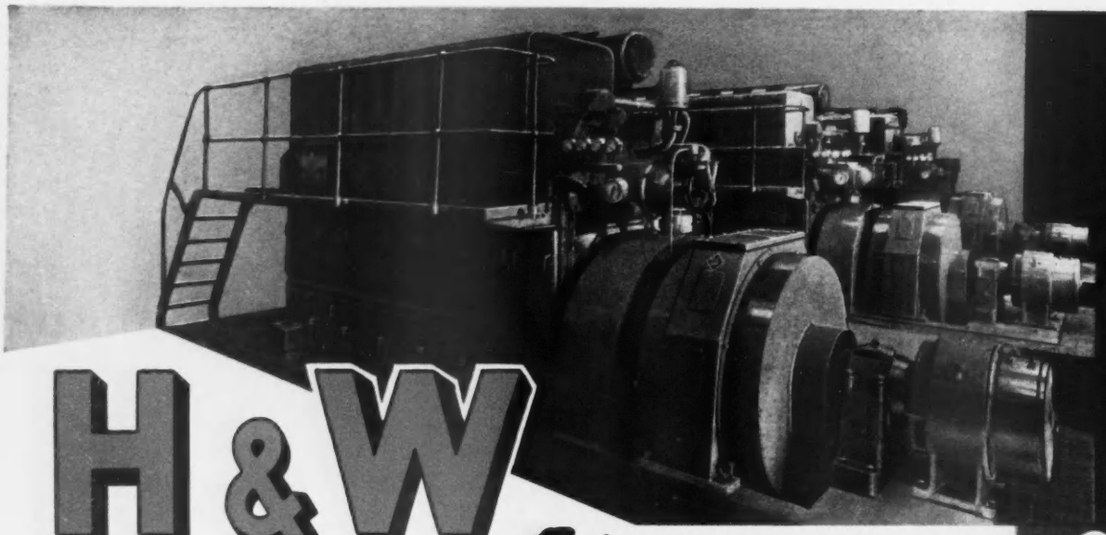

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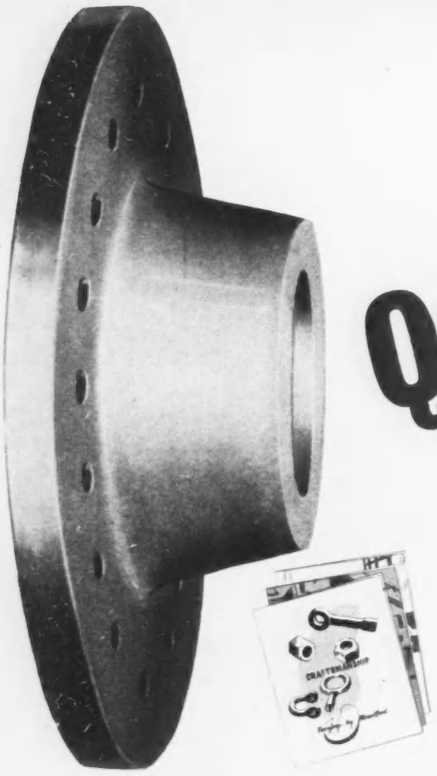

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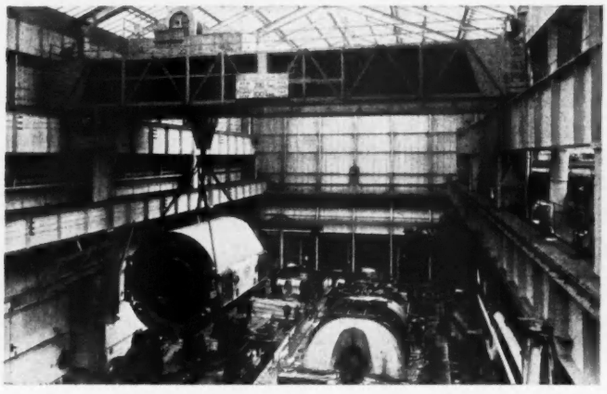

Clyde 200 tons electric overhead travelling crane in the turbo-generator erection shops of Messrs. C. A. Parsons & Co. Ltd., Newcastle.

This crane of 200 tons capacity is quite large as electric overhead travelling cranes go, but it is by no means the largest of our productions.

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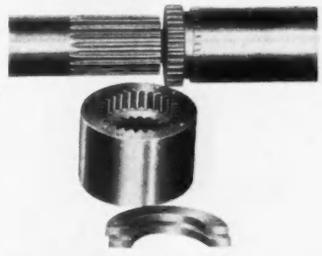

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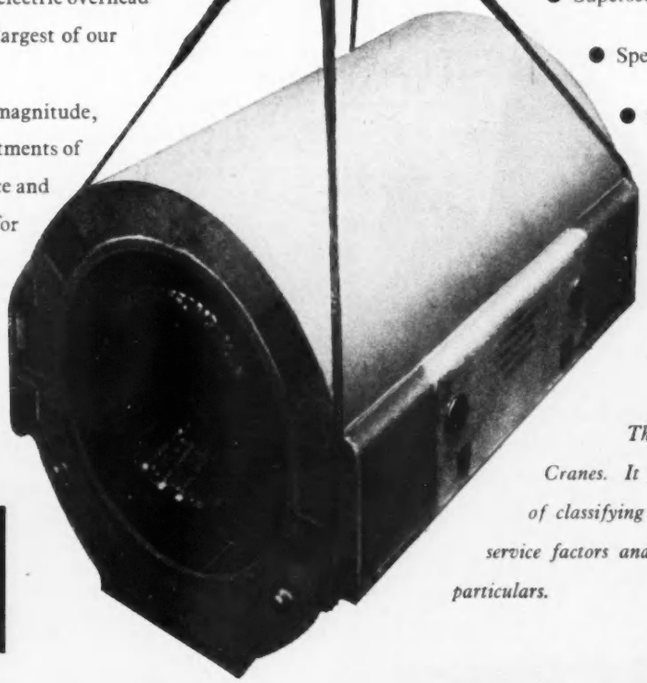

** If you are contemplating additional craneage, write for The Booth Handbook of Overhead Cranes. It fully explains the Booth method of classifying overhead cranes to suit varying service factors and may assist you in fixing crane particulars.*

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G

In this excavation in compacted Thames gravel 28 Jetwells dewatered an average exceeding 50,000 gallons per hour for the whole period of the contract. Contractors who have had experience in excavating waterlogged ground should note the extremely steep batter of the sides, no timbering or other supporting materials whatever being used. The Sykes Jetwells operated at a depth of 25 ft. A small sump 6 ft deeper than the remainder of the excavation was dewatered by the small installation of four Jetwells shown.

figures talk

Robustness, efficiency and simplicity are important characteristics of Sykes Dewatering Equipment, with which contractors' staffs can carry out extensive dewatering of open excavations and trenches without the need for constant supervision.
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DEWATERING EQUIPMENT

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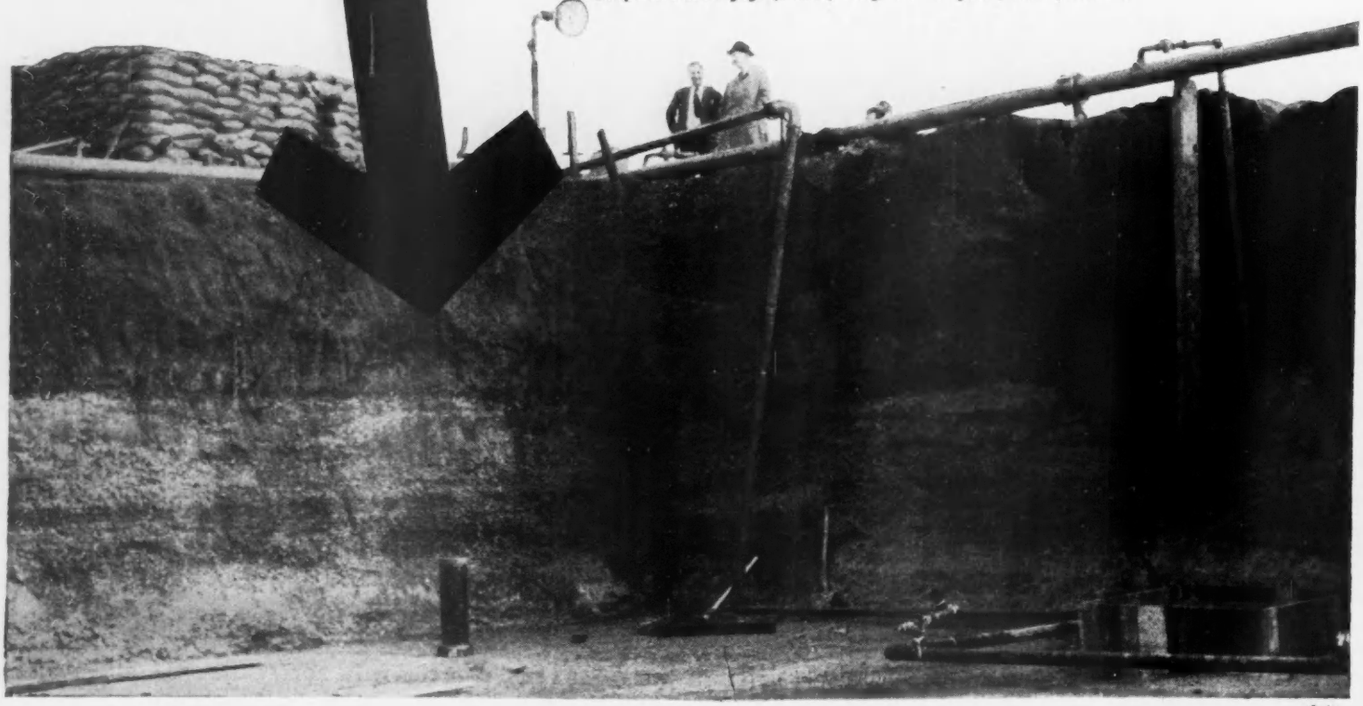

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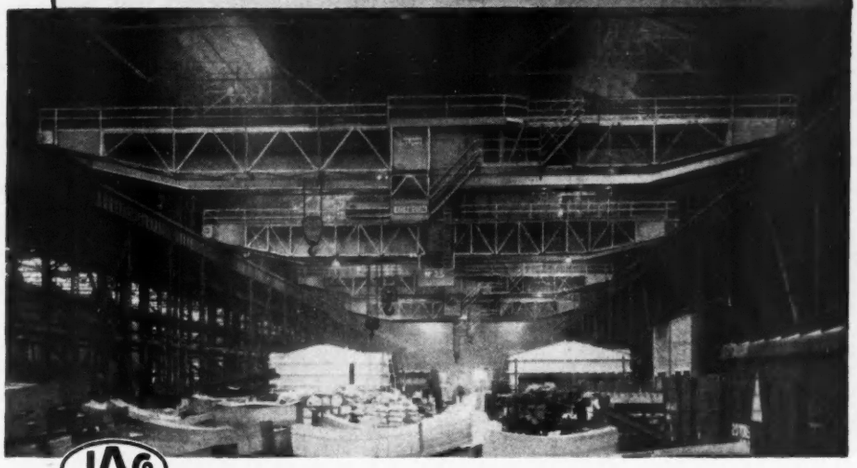
JOSEPH ADAMSON
Electric Overhead Travelling Cranes



JAC

All Joseph Adamson electric overhead travelling cranes are built to give unfailing service under the most exacting conditions. Generous proportions, provision for easy maintenance and the special attention given to operator control and safety measures are features of Joseph Adamson cranes. Electric overhead travelling cranes can be supplied to all specifications, including cranes suited to the most exacting 24 hours-a-day process work.

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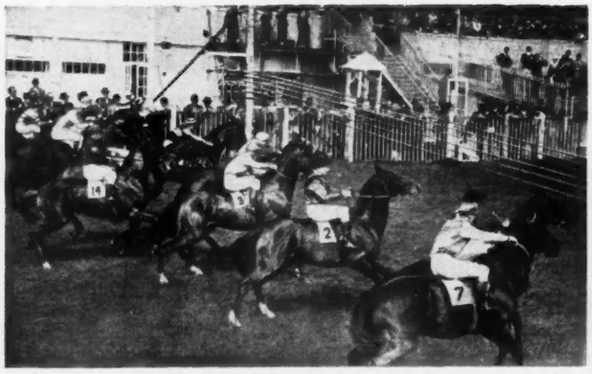
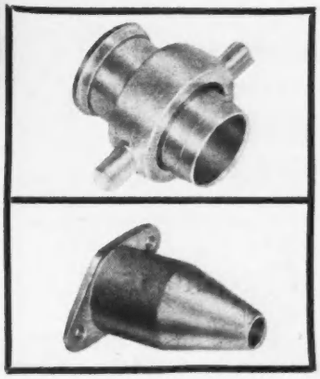


The choice is often difficult



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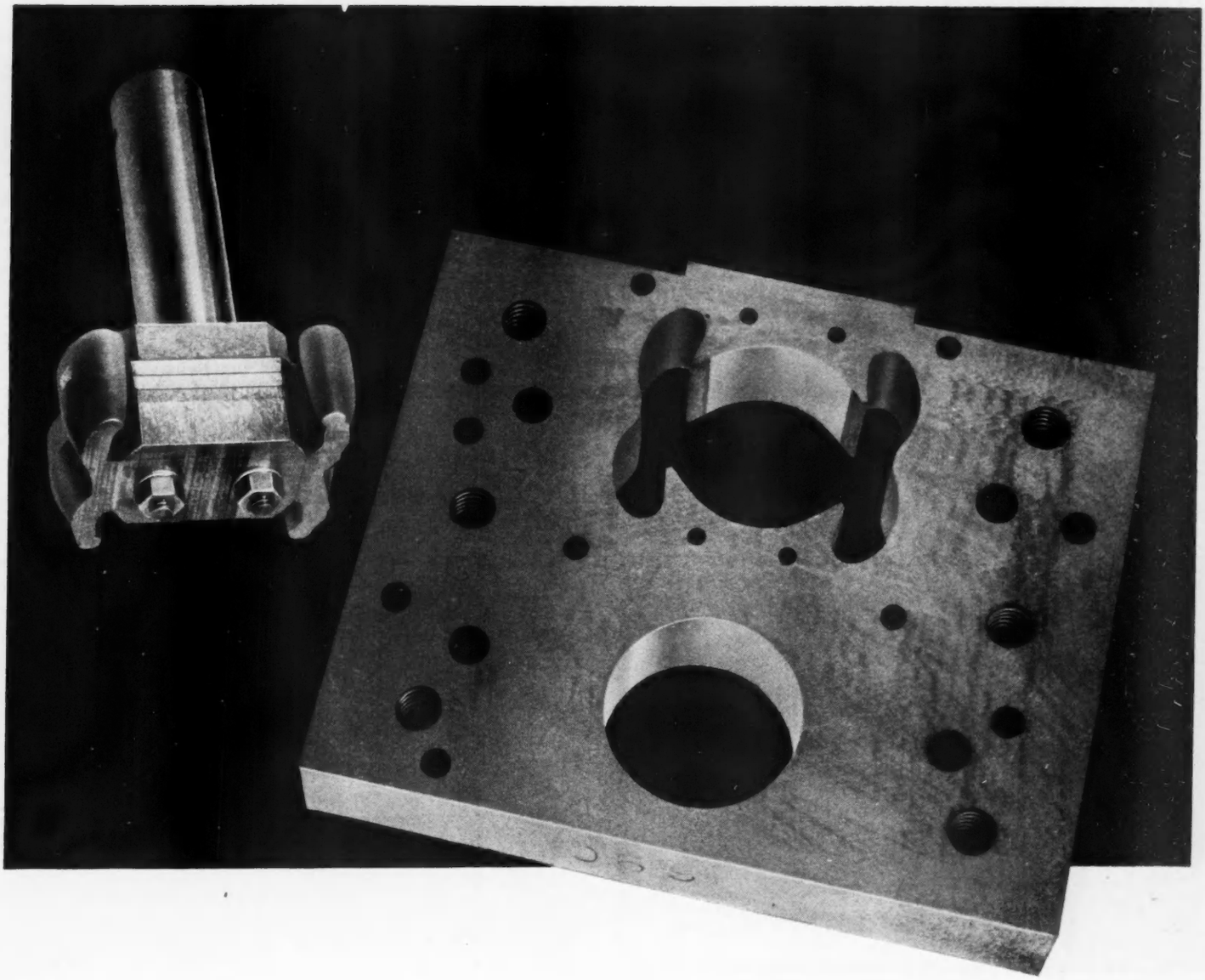

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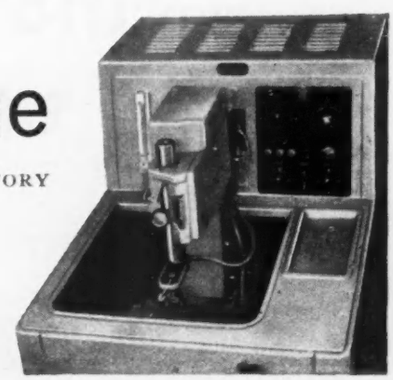

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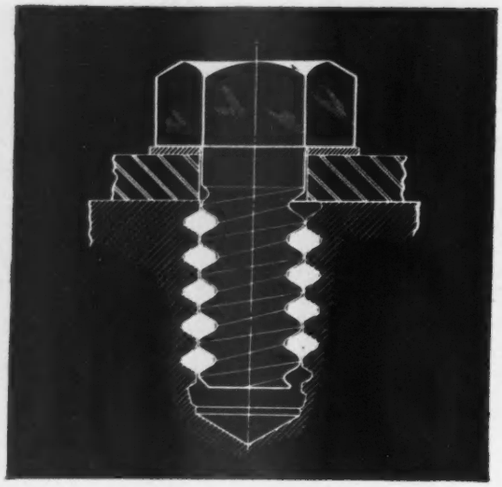

almost limitless possibilities of saving in time and cost

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screw thread inserts

Heli-Coil Inserts are self-anchoring thread liners made from high tensile stainless steel wire. In tapped holes they provide a conventional thread with higher loading strengths and greater resistance to wear and stresses than unprotected threads. The Heli-Coil eliminates stripping, seizing, galling and corrosion. It literally *armours* the thread. The Heli-Coil offers a unique opportunity for product cost revision. It is "a natural" for automation, it can make dramatic cuts in time and labour costs. Assembly is the ultimate in simplicity — just drill, tap and install. The Heli-Coil saves weight and space. It improves the serviceability and appearance of the end product. We suggest you write soon for data on Heli-Coil, the British-made Insert that is available internationally. It is a product of the day and this atomic age.

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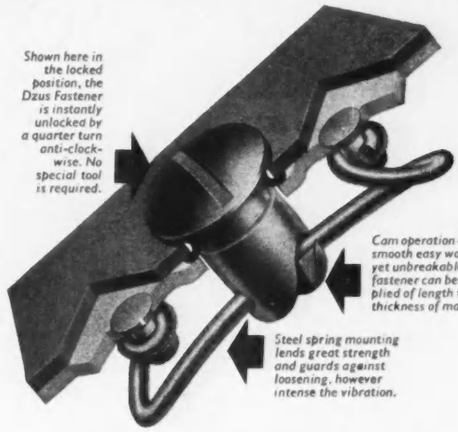
Shown here in the locked position, the Dzus Fastener is instantly unlocked by a quarter turn anti-clockwise. No special tool is required.
Cam operation ensures smooth easy working yet unbreakable grip; fastener can be supplied of length to suit thickness of material.
Steel spring mounting lends great strength and guards against loosening, however intense the vibration.

This is the fastener so widely used for fast assembly operations in the precision mass-production of today. It is indispensable for fastening hinged or removable parts which have to be cleaned, adjusted or inspected. DZUS Fasteners are easily applied to solid or laminated materials of any gauge. They have tremendous holding power but only an easy quarter turn clockwise is necessary to lock them fast, or unlock them.

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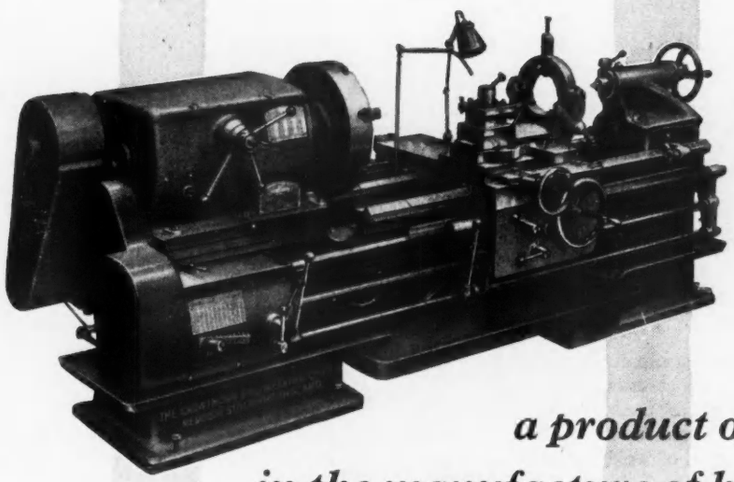

The new 10½in. H.D. lathe enhances still further the Crowthorn reputation for versatility and quality. Extra strength and improved design are matched by many entirely new features, for example:—Larger hollow spindle, 3⅛in. bore. Larger gap 36in. swing × 15½in. width. Completely redesigned bed. Larger and more powerful headstock for heavier cuts and higher speeds. Redesigned tailstock. Electric suds pump.

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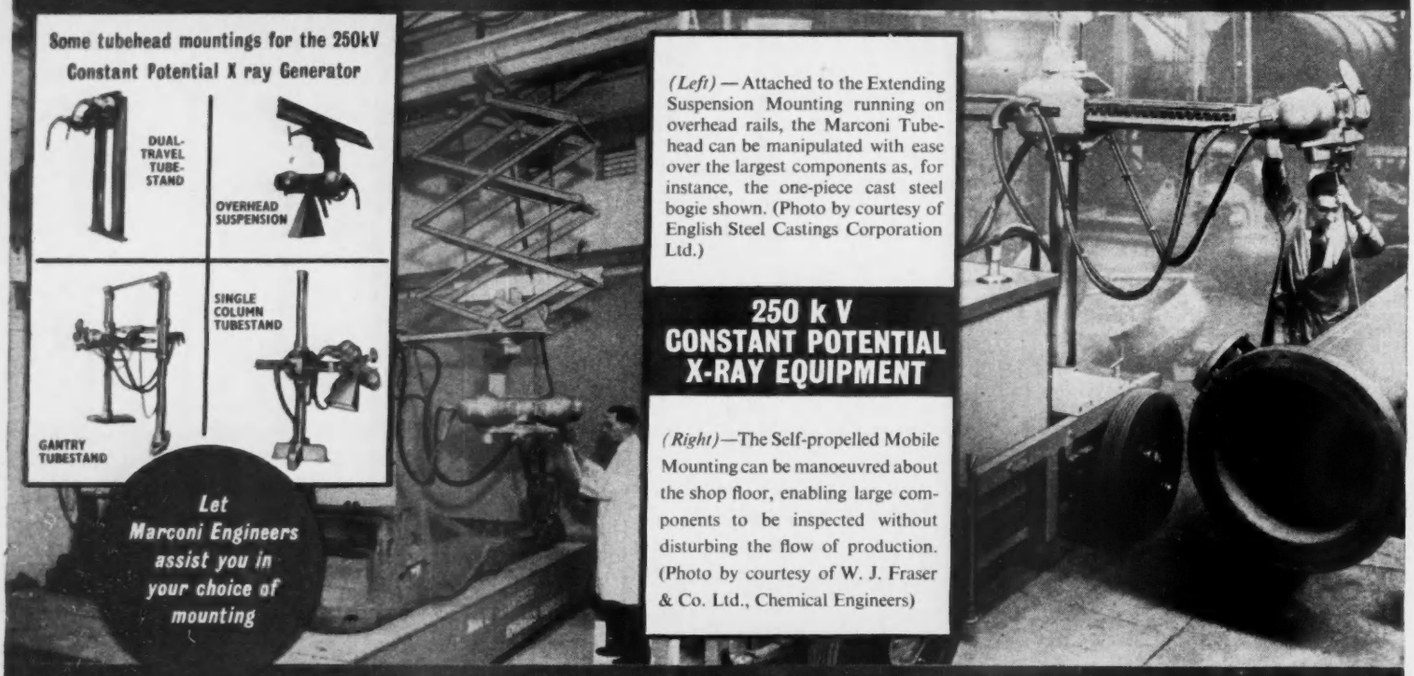
Some tubehead mountings for the 250kV Constant Potential X ray Generator

Let Marconi Engineers assist you in your choice of mounting



(Left) — Attached to the Extending Suspension Mounting running on overhead rails, the Marconi Tubehead can be manipulated with ease over the largest components as, for instance, the one-piece cast steel bogie shown. (Photo by courtesy of English Steel Castings Corporation Ltd.)

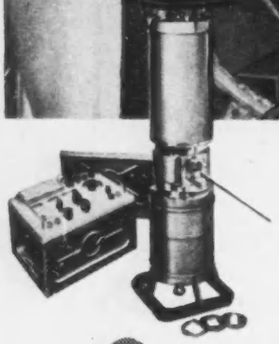
250 k V CONSTANT POTENTIAL X-RAY EQUIPMENT

(Right)—The Self-propelled Mobile Mounting can be manoeuvred about the shop floor, enabling large components to be inspected without disturbing the flow of production. (Photo by courtesy of W. J. Fraser & Co. Ltd., Chemical Engineers)

Generators and Tubehead Mountings for all types of work

THE ONLY BRITISH TRANSPORTABLE UNIT FOR BOTH PANORAMIC AND 40° TECHNIQUES

175 kVp. Circumferential welds can be X-rayed with one exposure. Moisture-proof, dust-proof and shockproof, it is British made and guaranteed for one year. Sample radiographs on request.



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110 kVp. A special fluoroscopic cabinet which also provides facilities for radiography.

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IX 20

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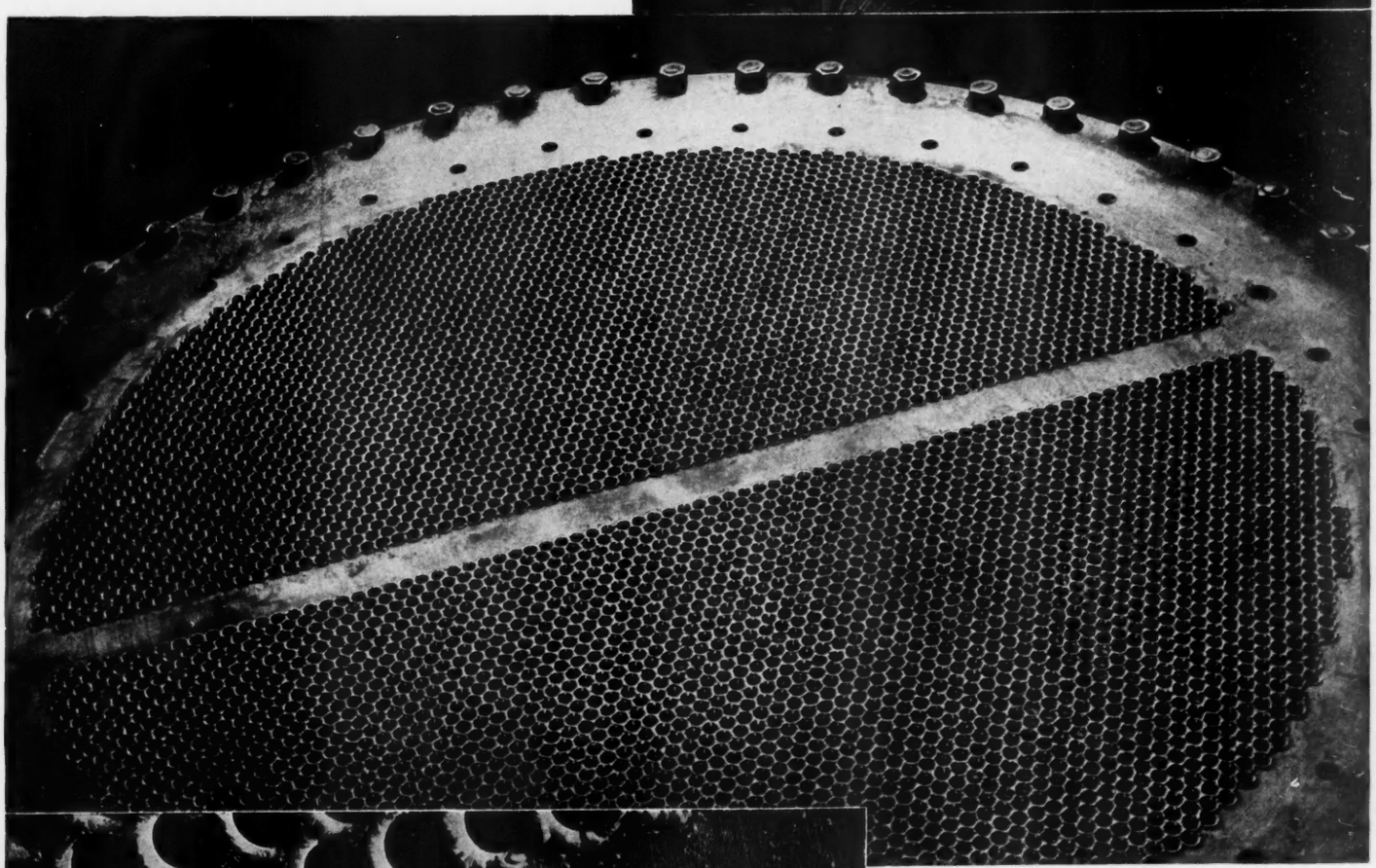

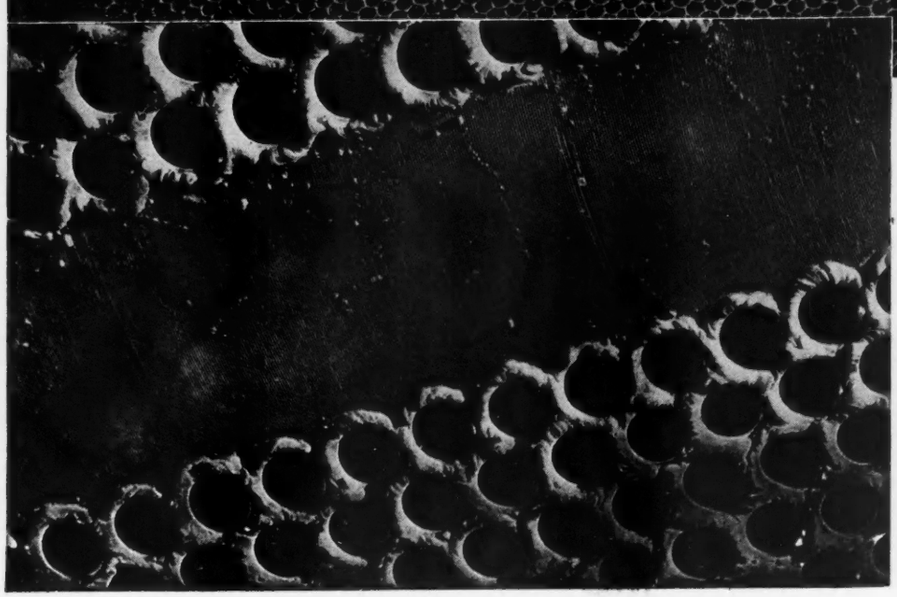

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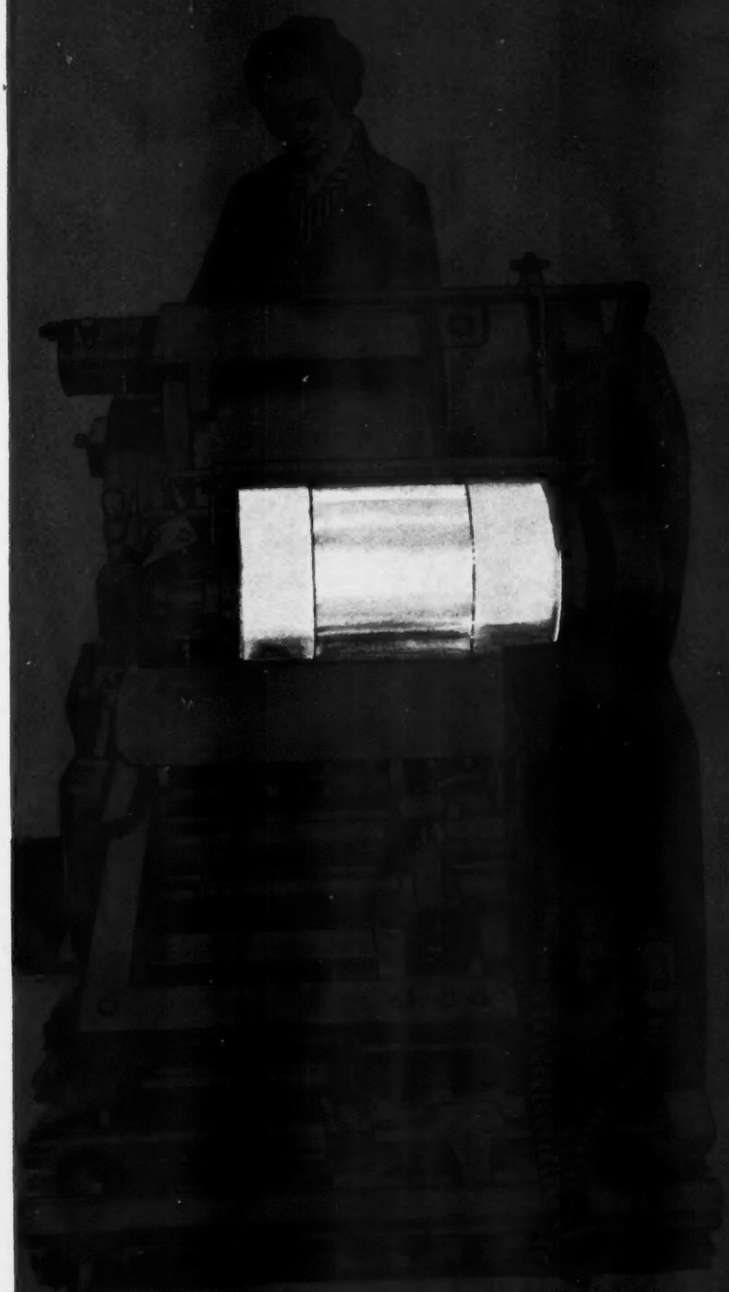
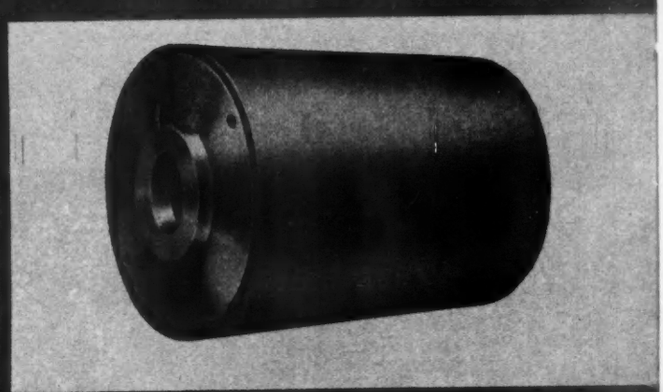


An important piece of equipment of the Paper Goods Manufacturing Company Ltd. is a polythene bag-making machine. In this process, polythene film is passed round a heated sealing drum. To prevent the film from sticking, the drum is coated with I.C.I. Silicone Rubber which is unaffected by the high temperature of operation and allows the process to work at high speed. At high or low temperatures—from 250°C to -80°C—I.C.I. Silicone Rubbers retain their flexibility—and their excellent electrical and chemical properties —without deterioration. If you have a problem within this range—electrical, chemical or mechanical—I.C.I. Silicone Rubbers take a lot of beating.



The sealing drum of this polythene bag-making machine, used by Paper Goods Manufacturing Co. Ltd., has a coating of I.C.I. Silicone Rubber, fabricated by The Dunlop Rubber Company.

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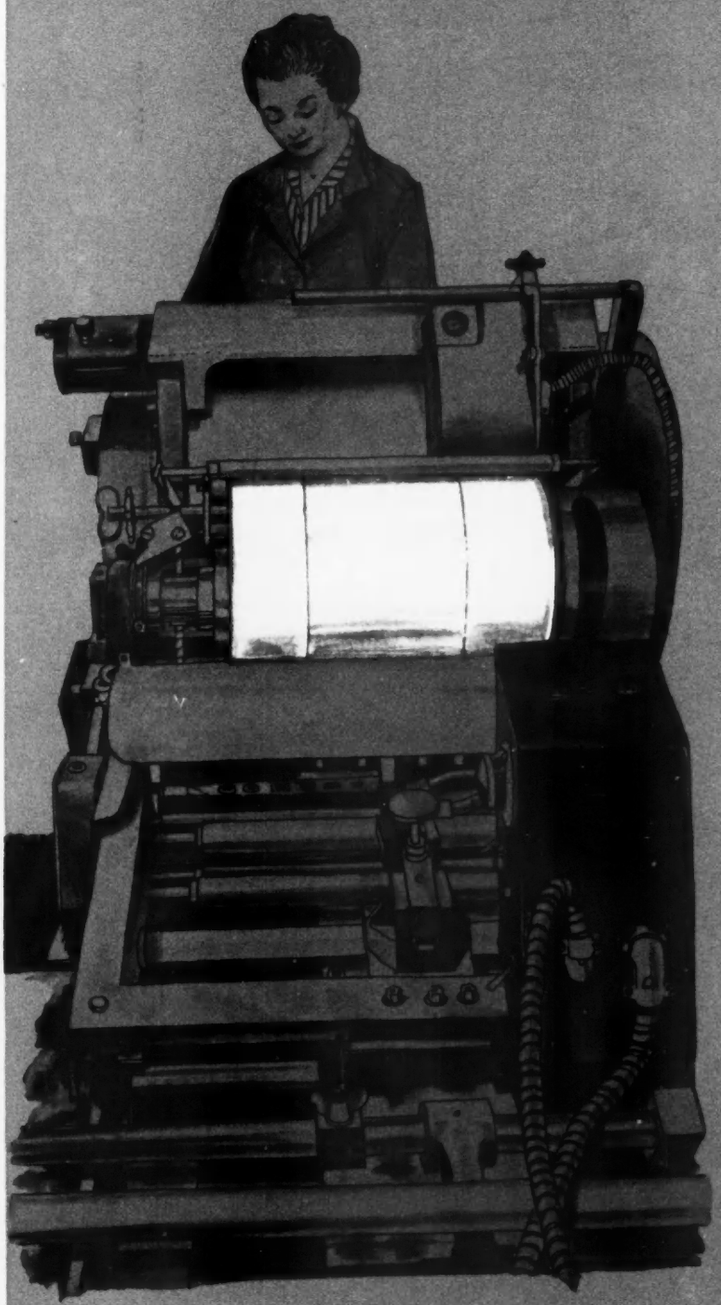

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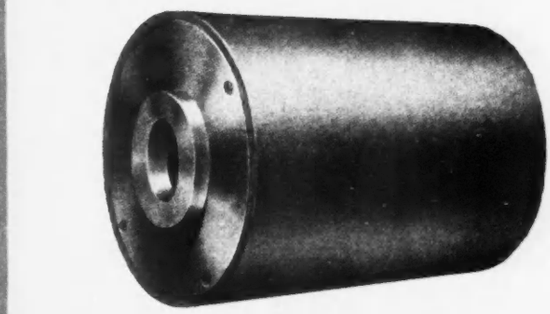

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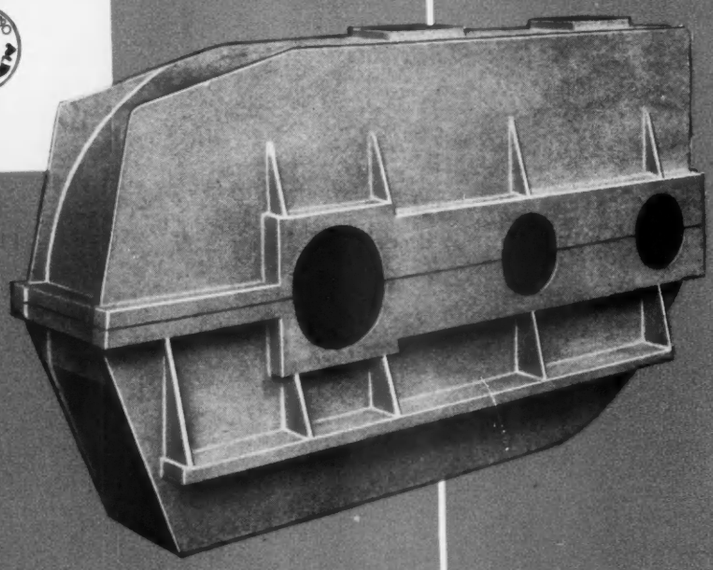

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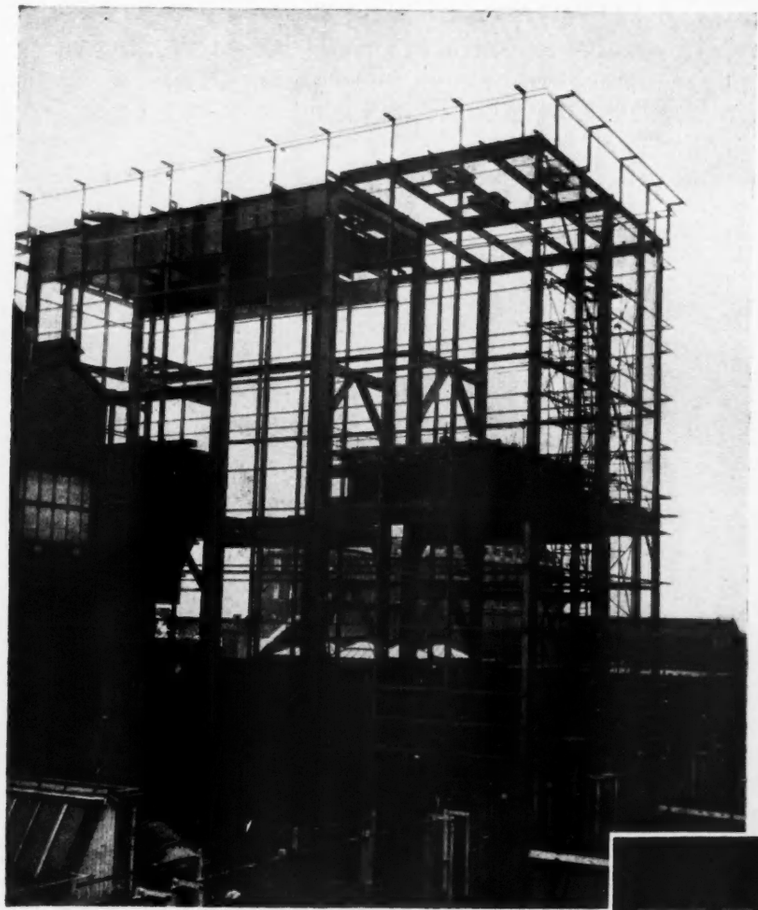

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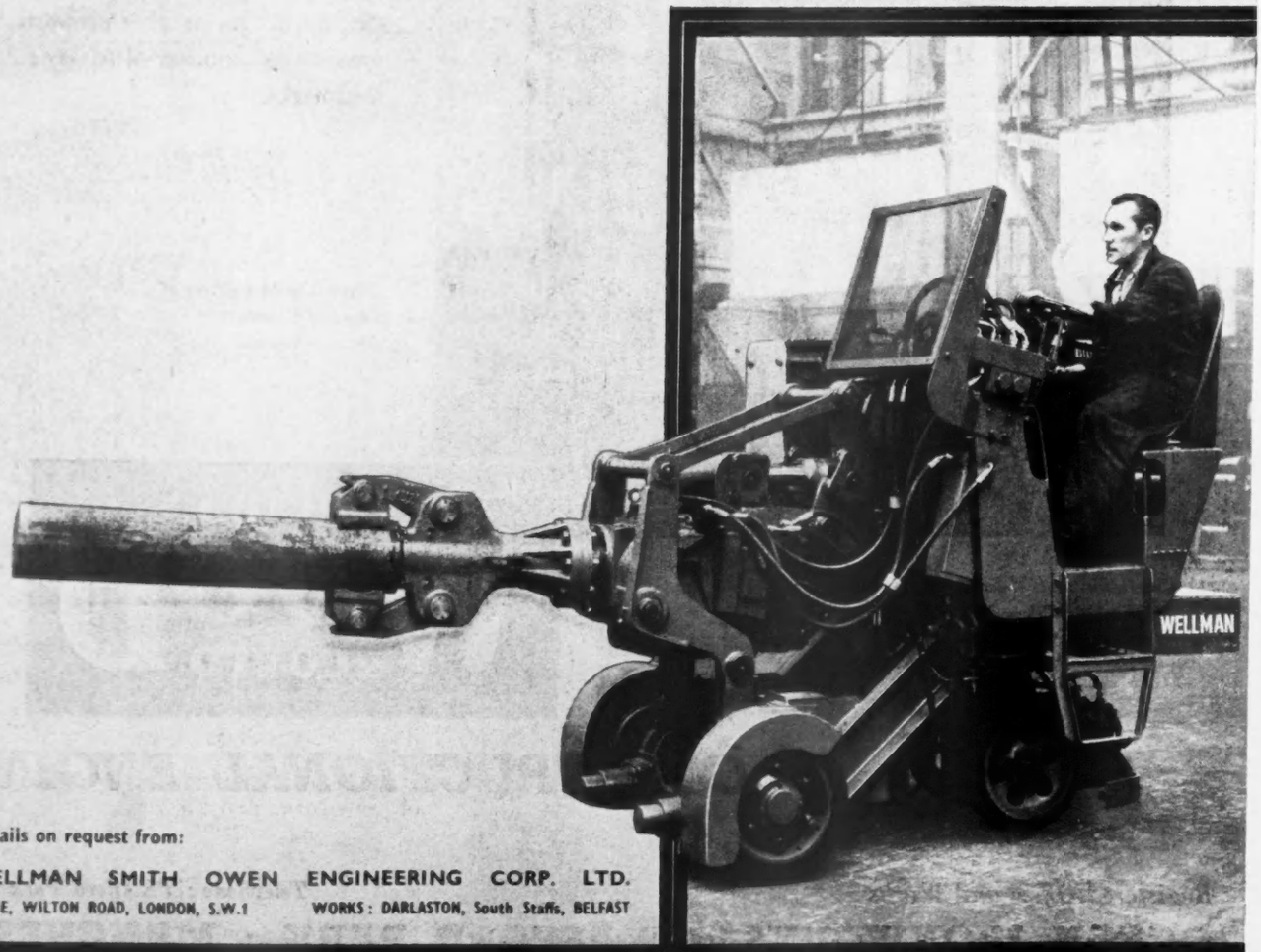

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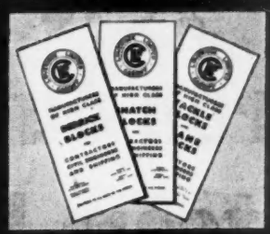

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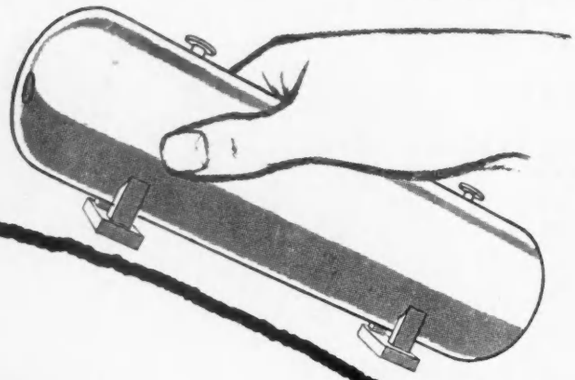

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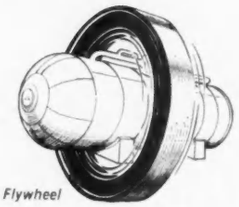

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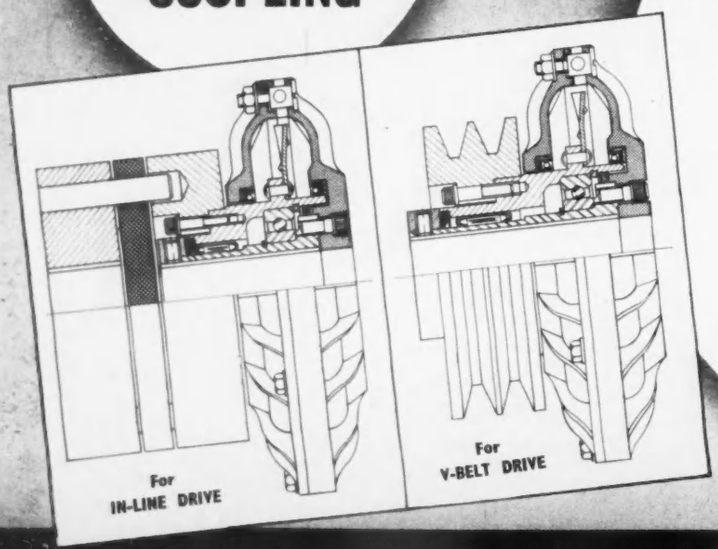

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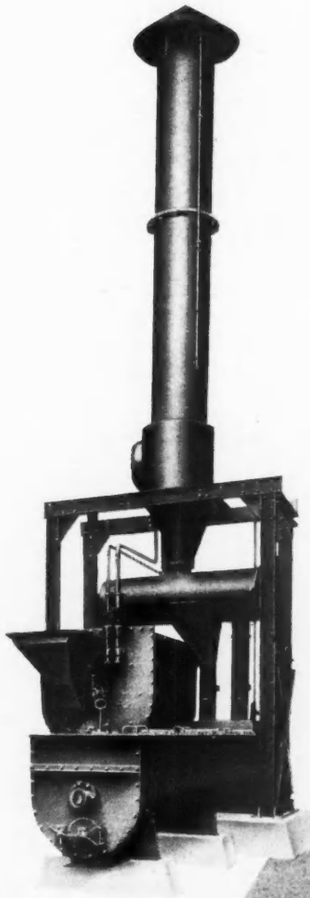

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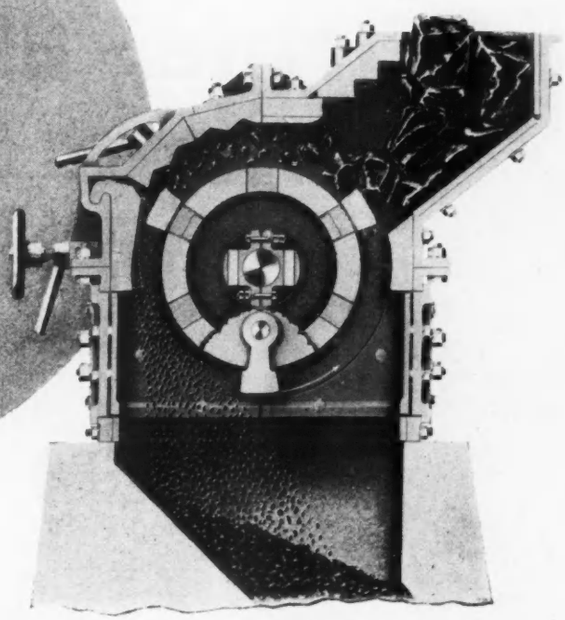

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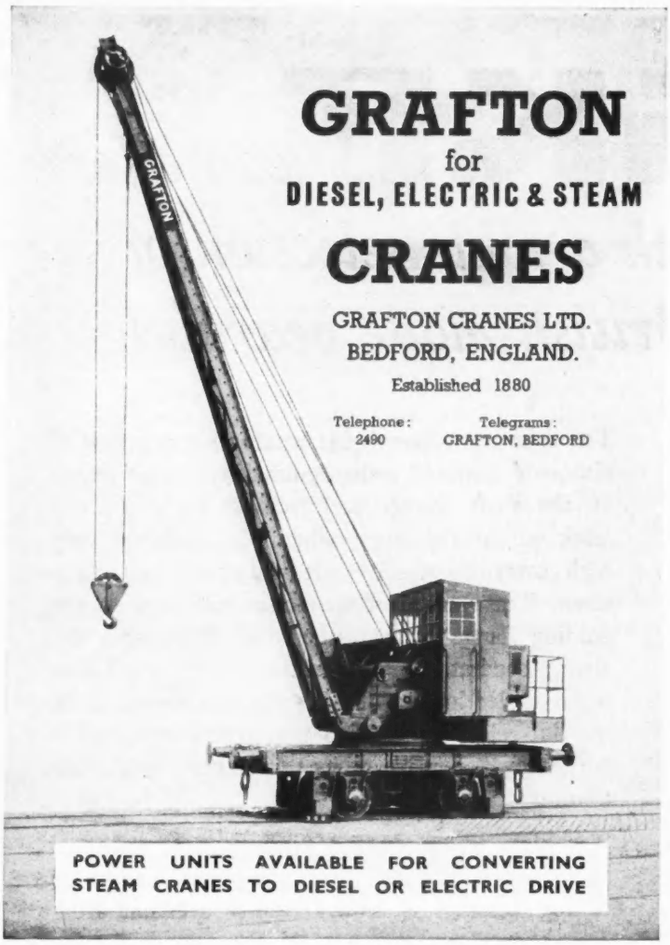

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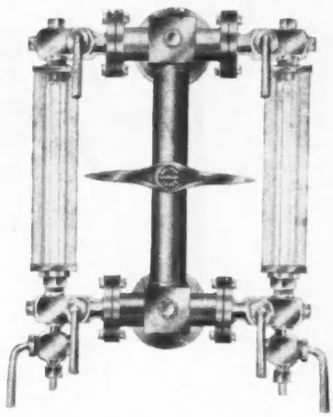

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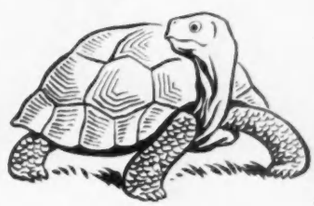

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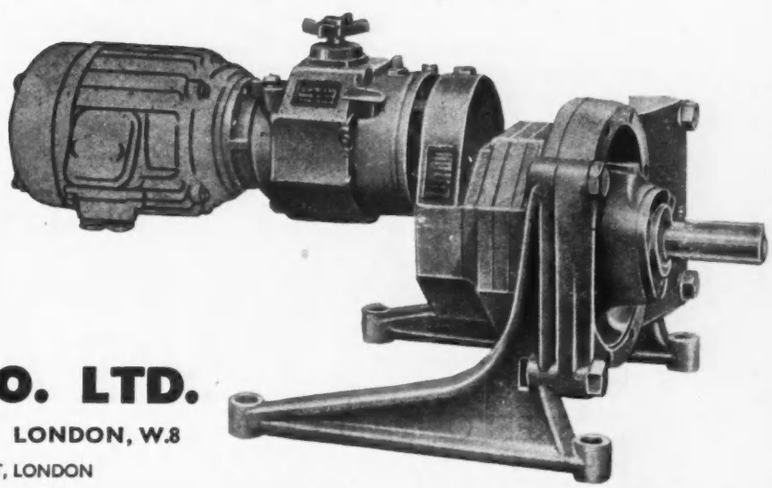

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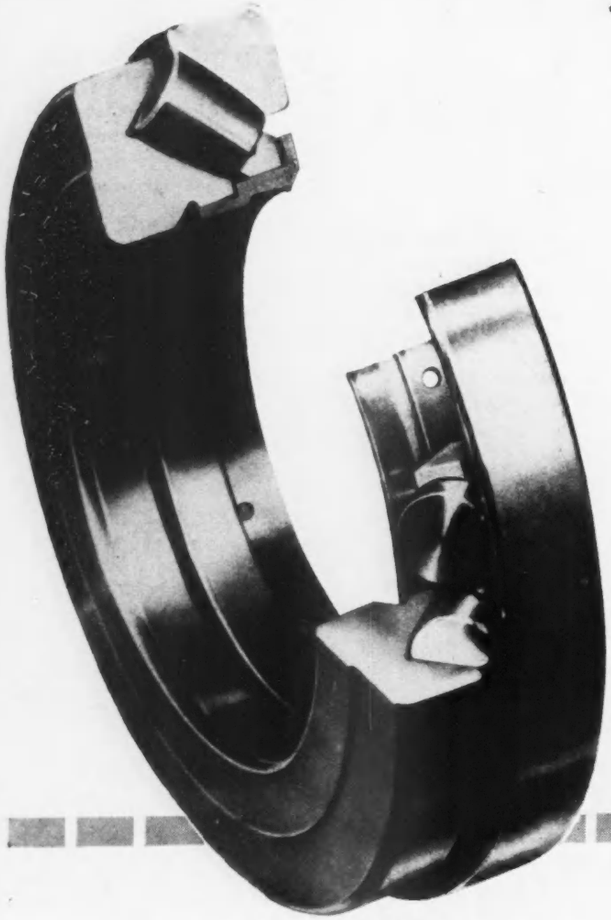

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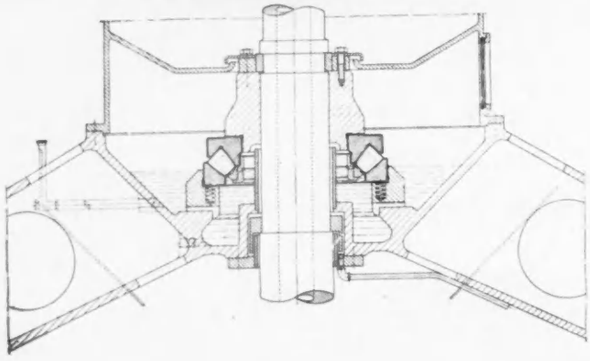
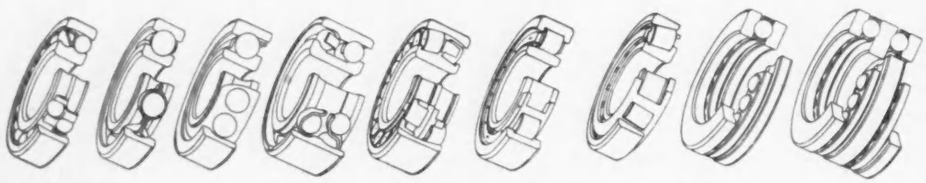


Support bearing for vertical electric generator



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THE ENGINEER

No. 5364 NOVEMBER 14, 1958 VOL. 206

F.B.I. AND NATIONALISATION

No one could ever expect the Federation of British Industries to give support to proposals for nationalising any industry. A reader of a report just issued by that body and entitled "Nationalisation" can assume, therefore, before he has even glanced at its pages that the conclusions drawn will all be inimical. Yet we hope that at least the less extreme amongst socialists will not be put off thereby. For, in fact, though in parts bias can be detected, there is here made a serious attempt to show on rational grounds that nationalisation must prove a failure. The document opens, for example, with statements quoted from Labour Party publications, giving the arguments for nationalisation and the comments upon those arguments seem to us fairly to expound their meaning. In subsequent chapters those arguments are examined in more detail and are shown, at least in the Federation's view, to be unsupportable. Broadly, we agree with that conclusion. But we think that the Federation in its endeavour to show what is wrong with nationalisation has in places overstated the virtues of private enterprise and the evils of nationalised concerns. Long before the electricity supply industry was wholly nationalised, for example, the country benefited by putting nation-wide control of electricity generation in the hands of a Central Electricity Board; and by the setting-up of the London Passenger Transport Board, long before transport was nationalised, the chaos that competing private enterprise buses were creating in London's streets was brought to an end. There are, in fact, certain public services, it seems to us, which benefit at least from public control if not from public ownership. We think, indeed, that nation-wide public control of water supply—to be best attained probably by nationalisation—would benefit the country and lead to much more rational exploitation of its limited water resources. But for productive industry as a whole, we believe the Federation's arguments to be quite soundly based. Nationalisation would reduce, not raise, the efficiency of such industries. It is true, of course (though the Federation fails to note it) that private enterprise in itself does not necessarily lead to efficient production. There are whole industries in this country—and no doubt other countries, too—which are technologically backward. But we do not think nationalisation is the true answer to the problem of making those industries conscious of possible advances. For what those who support nationalisation often forget is that whether nationalised or not an industry must be run by the people already in it. In performance, labour relations and several other characteristics, industries already nationalised have changed little, as the Federation's document points out.

Only in one respect can we see much to be said for the nationalisation of whole industries or the acquirement of control of them by governmental buying of equity shares. That argument is that the government in power thereby gains greater control of the nation's economy. Now it seems to us not possible to support by irrefutable argument the proposition that no government should have such great control of the nation's economy as is implied. For how little or great the control of a government over its people should be has never been completely decided. King Charles I held that ultimately all power and hence control should be vested in himself as head of the government. Parliament, incensed, removed his head. But in destroying his centralised power, they made it less possible for succeeding Parliaments to wield the same power; so that in Victoria's day the government had yielded up almost all power to control the economy. The socialists believe that a much greater centralisation of control in Whitehall than exists at present would benefit the nation. What paradoxes life provides! The Labour Party, supposedly the more advanced of the political parties, turns out to be the one which advocates a return to a system of centralised Government. No doubt it has the full support of the ghost of Charles I!

M.C.T.

Elsewhere in this issue we note the announcement of the National Council for Technological Awards that "in order to encourage qualified men and women to undertake further study beyond the level of the Diploma in Technology and carry out original investigations" an award higher than the Diploma is to be created. It is the intention that the award shall be a mark of outstanding distinction granted to a student who has proved his ability by completing a substantial programme of work "demanding the application of his knowledge to the solution of a problem of value to industry." A "College of Technologists" is to be established and the new award will take the form of Membership of this College. The gifted recipient of the award will be able to place the letters M.C.T. after his name.

But, we wonder, is a mistake being made? Is it really desirable to press on in this way to create a series of awards which parallel those made by universities? We write "series of awards" because it appears to us that the Council has it in mind to create further awards. The Dip. Tech. was created as the award to be made to a youngster satisfactorily completing a kind of course, significantly different from that offered by a university, but of a standard comparable with that of an honours degree. The Dip. Tech. for an engineering course is thus a qualification permitting its holder to enter the profession of engineering. But the M.C.T. will be nothing of the kind. It will be unnecessary to acquire it in order to make a success of after-life within industry. No doubt the Council has it in mind that teachers in technical colleges may like to go in for the higher award. But, we wonder, will they not prefer a university doctorate? Again what the Council hopes is that the existence of the new award will encourage men already in industry to undertake advanced research of an industrial rather than an academic character. The distinction is undoubtedly real. But we do not think universities award higher degrees solely for work of an academic character. Indeed many of the post-graduate courses organised by univer-

sities are closely related to and designed to throw light upon industrial research, development, design and production, though not perhaps upon market investigation. Since the universities have apparently signified willingness in appropriate cases to admit holders of the Dip. Tech. to courses of study for higher degrees there is likely to occur in the minds of men desiring higher qualifications the question whether to work for an M.C.T., an award which has still to acquire its own prestige and may never acquire it, or to work for a university award of established prestige. Again, does the kind of man who will prefer a Dip. Tech. course to a degree course desire to acquire anything more in the way of an award than one which satisfactorily launches him upon a professional career ? We know plenty of people in industry who must certainly have had when younger the ability to acquire by suitable study or suitable work some higher award than a degree. Yet they have never bothered to do anything about it because its acquirement would be irrelevant. Their reputations depend not upon letters after their names but on the quality of the work they have done and continue to do. We do accept, we have always accepted, the proposition that it is good to set up an award for a kind of education at a technical college and in industry which is distinctively different from that provided by a university. That award should and will qualify a man to enter his profession. Because it will do so it should prove at least as attractive to many men as a university degree. But can further awards, which must be made much more directly in competition with those which universities make, prove really successful ? We ask because if those higher awards fail over the years to acquire high prestige there may be reactions upon the prestige of the Dip. Tech. itself. That would be very unfortunate !

UNHAPPY RAILWAYS

In 1956, when British Railways entered upon its great and expensive modernisation programme, it was calculated that by 1961 or 1962 the accounts of the British Transport Commission would balance and that thereafter clear profits would be earned which could be used to pay off debts. On that basis the Government, under the Transport (Railway Finances) Act of 1957, authorised the borrowing of up to £250 million by the British Transport Commission to cover deficits during the intervening years before modernisation became effective. The Commission made its 1956 estimates " on the basis of the present value of money and a continuance of current economic conditions." In fact, however, there has been a contraction in the present year of the nation's output and in particular of the output of the coal and the steel industries. Since, between them, coal traffics and steel traffics, including minerals, account for some 60 per cent of British Railways' freight receipts, there has resulted a conspicuous fall in railway earnings. During 1958, according to a report of the chairman of the Commission to the Minister of Transport, it was planned to make certain economies and savings by reductions of staff and of the numbers of wagons operating, by the closing of unremunerative lines and reductions of certain services, and so on. Those savings seem effectively to have been made. By those measures it was estimated that the deficit for the year, after taking central charges into account, would be no more than £55,000,000. But the unexpected shortfall of receipts amounts to £30,000,000, so that for 1958 as a whole a deficit of some £85,000,000 is to be expected. Adding in deficits for previous years, £200 million will have been borrowed by the end of the year ; and unless there is a pick-up in freight traffics of an order little short of miraculous in the early months of 1959, the Commission's borrowing powers will have been exceeded some time in that year. Of any business other than a nationalised one it would be true to say that it was facing bankruptcy. In fact, however, the Government is to come to the rescue and to advance the necessary funds.

It is a sad business. When, in 1956, Sir Brian Robertson put the Railway Modernisation Plan forward it was clearly his intention to boost the morale of railwaymen by convincing them that the railways could, should and would pay if only the Plan were vigorously pressed forward and money was lent to carry the Commission over the period before the Plan could fructify. All engineers interested in railways (and how few do not wish them well !) admired Sir Brian's courage, even if they doubted whether what he promised could be performed. The outcome of the working of 1958 unfortunately cannot but be held to support those doubts. For the basis of the 1956 calculation is shown to have been that this country's industry should enjoy steady and continuous expansion. It is surely too much to expect. It is more probable that the expansion will be discontinuous and interrupted at intervals by just such checks as that now being experienced. It seems necessary to assume that each time there is such a check in the future—whether or not the Commission can earn a profit intermediately—the railways will be run at a substantial loss. Of course, we, and engineers in general, hope any such prognostication will be proved wholly wrong by the event. But coming events may be casting their shadows before them. Despite the expenditure of some £500 million by 1962 it may be that the railways, though modernised, may not pay. What will the country do then ? Will it agree to subsidise the railways indefinitely ? Or require a much more wholesale closing down of uneconomic lines than has so far been contemplated ?

RENNIE OR SMEATON FOR THE INSTITUTIONS ?

It is good for everyone to be shaken up now and then. So we do not think the members of the Institution of Civil Engineers will have come to any harm from certain words which Professor Pippard dropped into his Presidential Address. Those words—we extracted them from the Address and printed them in our last issue—will have made the members " sit up and take notice." We hope they will also have led them to ponder and discuss them. Naturally Professor Pippard is no admirer of that remark of Smeaton which he quoted: " In my intercourse with mankind I have always found those who would thrust theory into practical matters to be at bottom men of no judgment, and pure quacks." No professor could like that statement and it is not surprising that Pippard prefers Rennie, who held that true practice could only be based on true theory. Nor was there anything very surprising about the Professor's opinion that in the near future very few candidates for admission to the Institution would be admitted without qualifying degrees or diplomas and that in the more distant future such an education would become obligatory. But the more practically minded in his audience may have been surprised when he said that the most important function of practical training for young men is " the amplification of theory by experience " and went on to imply that it is desirable in order to " make possible the full use of the scientific education they have received." For " Smeatonians " would put the emphasis the other way round and suggest that practical training should knock some of the academic nonsense out of young men's brains ! But what may have particularly shaken the bulk of the members, additional to those of Smeatonian sympathies, was Professor Pippard's plea that the Institution should welcome to membership

more generously " engineering scientists " who " constitute a definite and essential branch of our profession." Further, to make it quite clear what he meant he added " I believe that men or women who are seriously engaged in research in fields of importance to the civil engineer should not only be permitted to join us on equal terms with practitioners if they so wish, but should be actively encouraged to do so." Quite clearly—for Professor Pippard cannot stand alone—the Council of the Institution of Civil Engineers, like the Councils of the Mechanicals and Electricals, is beginning to wonder whether nowadays there should be as much insistence as there used to be upon an applicant for membership having had a lengthy period of practical training. A further shock, however, was to follow. Professor Pippard felt that war experience impressed upon the national conscience " that a completely new era in science had opened and that if the United Kingdom were to maintain a leading place among the nations her engineers and technologists in the new age would have to be capable of applying the great discoveries which were emerging." Unless therefore engineers—or some engineers—became engineering scientists there was a danger that the engineer would find himself " relegated to the role of technical assistant to the pure and applied scientist." Clearly what Professor Pippard has in mind is that if through hard and fast rules excluding men with less than a certain minimum of practical experience engineering scientists are excluded from the major engineering institutions then there will be excluded from those institutions the very men who are making revolutionary engineering advances possible. In certain electrical fields of endeavour that might be said to be already the situation and it has led the Council of the Institution of Electrical Engineers to be the first seriously to study its requirements for entry. But in civil engineering too one can observe how in the last twenty-five years or so the academically inclined, by the development and extension of theory have opened out new possibilities in structures. Are we right therefore to persist in believing that a sharp distinction can still be drawn between engineers and scientists ? That we suppose is what Professor Pippard is asking. Would it not be better to welcome into the engineering institutions anyone responsible for making engineering advances without setting up an artificial " practical " qualification ? We hope Professor Pippard will have set engineers talking. For the question is important. Within the last fifty years more and more firmly the major engineering institutions have come to reject the proposition that a practical man without much command of theoretical knowledge can be regarded as a fully qualified professional engineer. The sole concession to Smeaton is that a limited amount of practical training and experience is still insisted upon ; but the time to be devoted to it has been shortened. How far should the pendulum be permitted to swing ? It is one thing to suggest, as we have done, that the nature of the practical training should be altered. It is quite another to let the pendulum swing all the way, as Professor Pippard appears to desire, and admit to membership men with satisfactory academic attainments who have gone straight from universities and colleges into engineering research laboratories. Even Rennie might have been startled by that proposal.

TRAIN ACCIDENTS

When discussing the annual reports on accidents which occur on British Railways it is often tempting to concentrate attention on the number of fatalities and injuries without appreciation of the low proportion the figures represent expressed as a percentage of the number of train miles which are run. The report of the chief inspector of accidents for the year 1957 shows that of the 139 passengers who lost their lives, ninety-two lost them in train accidents, forty-six in movement accidents and one in non-movement accidents. Of 8480 passengers who were injured 833 suffered in train accidents, 4732 in movement and 2915 in non-movement accidents. Amongst railway servants four were killed in train accidents, 147 in movement and twenty-five in non-movement accidents, whilst a total of 15,538 were injured during the year. An analysis of the accident figures shows however that only 0·7 persons were killed and 18·7 were injured per million train miles run during the year under review, when the passenger journeys (including season tickets) originated totalled 1630 million.

The report points out that there were 1205 train accidents in 1957, but no less than ninety of the ninety-two passenger fatalities occurred in only three collisions, one derailment and one open door collision accounting for the two other deaths. The number of accidents caused by train crews was 310, and collisions and derailments so caused totalled 233. It is considered that the extension of automatic warning control to all main lines and the provision of more colour light signalling will do much to aid train crews. The report concludes, however, by saying that the apparently unaccountable lapses on the part of drivers to observe signals remain a problem. Unaccountable those lapses may be. Yet men are not gods! Even the most highly trained and apparently the most trustworthy cannot be wholly trusted never to make a mistake. Wisely what the railways have aimed to do, is to prevent any individual mistake having serious consequences. As the figures show they have proved and continue to prove remarkably successful.

The Engineer—100 Years Ago (NOVEMBER 12, 1858)

" ENGLISH AND FOREIGN ENGINEERS "

" English engineers are not noted for professional failures, whatever may have been the commercial results of their executed works. But in respect to economy it has been supposed that the Americans evinced more practical talent in the ready adaptation of means to ends, and that their standard of engineering was on the whole the most successful to be met with. While our early lines of railways were carried nearly upon dead levels, with curves of noble radii, the Yankees did not stick at gradients of 1 in 50, nor curves of ten chains radius. While we erected bridges worthy of the highest period of Roman grandeur, our cousins perched their thoroughfares upon ' trestles ' of most economical proportions, if not of most dubious equilibrium.

" In canals, harbours, shipping and other departments of construction, the American engineers had usually some short cut or other by which they appeared to attain nearly the same results as ourselves, and apparently at scarcely one-fifth of the cost. It was hence argued, that in the prosecution of engineering works in other countries our professional men would encounter a strong American competition . . . . In the meantime many changes were going on in England. Light and economical, but durable structures of iron, were being erected where stone only had been before employed : steeper gradients and sharper curves were tolerated, and plain but comfortable stations and spacious but economical workshops were erected. First class railway construction has been reduced nearly to the American standard. On the other hand, the boasted system of that country has been found to be of the penny-wise but pound-foolish description. The publication recently made by Messrs. Colburn and Holley, actually under the auspices of several American railway companies, proves, beyond doubt, that a large measure of the success of those works has been and is being yet sacrificed to a rude and vicious system of engineering."

Simulated Service Life Testing

By TIBOR HAAS, Dipl.-Ing., A.M.I.Mech.E., A.F.R.Ae.S.*

No. 1

The discrepancies between the fatigue strength of parts in service and the fatigue strength of the material, determined on small laboratory specimens, led in recent years to the general adoption of full-scale tests on components and assemblies in a number of industries, thereby fulfilling the first requirement of realistic testing. The second requirement, which represents a departure from idealised and standardised test conditions, stipulates a close simulation of the loading actually met with under service conditions. This article, illustrated by examples taken from the aircraft field, describes a method and equipment used by Bristol Aircraft, Ltd., to keep pace with requirements of realistic endurance testing.

IN the past, the classical method of engineering design was based on the static strength of materials when safety factors on stress covered all the unknowns due to deviations from theoretical conditions. Where repeated loading was involved, the assumptions of static design were generally adequate as the allowable stresses were of such magnitude that life was infinite. At that stage of development a knowledge of the fatigue limit was the only additional requirement for dynamic design, but in spite of the intention of keeping the stresses below the safe limit, the ever-present local stress raisers were giving trouble and in almost every industry numerous unpleasant and more than a few calamitous failures have been recorded.

With the advent of new materials and the demand for increased performance and utilisation, finite life design tended to become the rule, when the determination of the *S-N* curve (Fig. 1) was called for. Each point

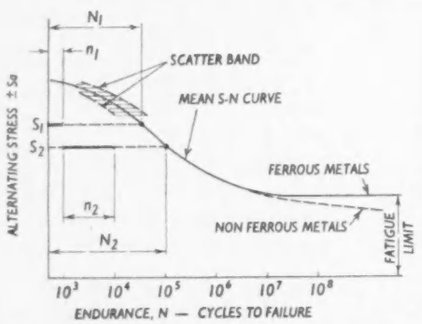

Fig. 1—Schematic *S–N* curve. Alternating stress $\pm S_a$ plotted against cycles to failure *N* at constant mean stress S_m

on the *S-N* curve corresponds to a given stress level which is associated with a certain life to failure. Each stress level represents a constant amplitude of alternating stress ($\pm Sa$), applied about a constant steady stress, the mean stress (Sm), i.e. for a given stress amplitude the stress alternates sinusoidally between constant upper and lower limits. The sinusoidal wave form is common in testing but it is of little consequence what the actual wave form is as long as load limits are constant. Inherent in the demand for long lives at stresses well above the fatigue limit was the growing realisation that the fatigue test was tending to replace the static strength test as a criterion for proving the design strength. This trend was fortified by the recognition that fatigue results were not independent of size and shape effects and that therefore testing had to be conducted on full-scale design elements and assemblies. Such is the practice to-day and it was already beginning to establish itself twenty-five years ago. With the conventional fatigue test, applied to parts of machines which receive in service predominantly constant-level cyclic loading, such as stationary engines, turbines and other high speed machinery, the results proved satisfactory. However, there are numerous machines and structures subjected to non-periodic or random loading, whether for example due to locomotion such as is the case with vehicles, ships and aircraft, or to moving loads as is the case with cranes and bridges, where the present position, which the above necessarily somewhat sketchy and over-simplified historical outline has attempted to convey, is far from satisfactory. For a long time it was held almost axiomatically that any testing machine that could apply random loading or vary the stress level incrementally would have to be vastly more complicated and expensive than a corresponding machine for testing at a constant stress level and would introduce also more sources of experimental error, reducing thereby the chances of conclusiveness of test results. In the light of subsequent knowledge these fears proved to be groundless. However, in the meantime effort was concentrated on finding a valid correlation between the fatigue performance at varying stress levels representative of service, and the *S–N* curve. As early as 1924, Palmgren, investigating the life of ball bearings, established a linear relationship ; Langer in 1937 reverted to the problem, but it was Miner[1] in 1945 who resuscitated it, and it is his "linear cumulative damage rule" which is best known to-day. It assumes that the total work done to failure at any constant amplitude level is unity, and therefore the number of applied cycles n_1 at stress level S_1 (see Fig. 1) divided by N_1, the number of cycles to failure at the same stress level, i.e. the ratio n_1/N_1, represents the fraction of available life spent. Thus, the sum of all fractions at the various levels concerned is unity, or $\Sigma(n_1N_1)=1$.

This rule, if it held good unconditionally, would provide a reasonable chance of determining the endurance life of design members under varying loading conditions. However, the cumulative-damage rule makes no statement as to the chronological sequence of stress cycles of varying amplitude, although it is a well-known fact that the effect of varying sequence is by no means negligible. For instance, if a design member is first subjected to stress cycles below its normal fatigue limit and then tested at higher stress cycles, it will generally show an improvement in fatigue life. This is known as understressing. Similarly, over-stressing refers to loading a design member above its normal fatigue limit for a relatively large number of cycles before loading it at another stress level. This reduces life, although only a few high-stress applications prior to retesting, known as prestressing, generally improve endurance. It can be shown that the mechanism of damage is different at different stress levels, and damage is not uniform, as assumed by all the cumulative-damage concepts.

As the linear cumulative damage rule or any other of the exponential damage hypotheses which were proposed, can be greatly in error either on the safe or on the unsafe side, the gap between the fatigue performance of parts in service and the fatigue strength based on constant amplitude tests could no longer be bridged by large safety factors. Of course, in principle, a "safe" method would be to design for infinite life. However, to assume that the infrequently occurring high loads should be producing stresses below the fatigue limit would be irrational and extremely wasteful, and in such fields as, for example, aircraft or motor-cars even unrealisable owing to the added weight this would entail. Also, most light alloys have no definite fatigue limit (Fig. 1), and thus the need for design for finite life under random loading conditions must be accepted as inevitable, no matter from which angle the problem is viewed.[2]

It is not surprising, therefore, that engineers who were not so much concerned to solve the cumulative damage problem as to get over it, were looking towards a purely experimental solution which would enable them to reproduce on the specimen the same statistical load-frequency distribution, known as the load spectrum, that characterises the random loading to which the design member is subjected in service. Such ideas led Gassner,[3] in 1938, to establish the principle of a testing method which is variously known as spectrum loading, programme loading, service-endurance testing and performance-fatigue testing. In Cazaud's book,[4] Chapter IV, paragraph 17, "Tests under Incrementally Varied Loads," concludes as follows : "This type of test provides the closest approximation to service conditions, and the development of the means of conducting such tests constitutes an important advance in testing technique." It can be said that this advance is finally embodied in a testing machine, to be described here, which represents the outcome of years of development work by its makers, Messrs. C. Schenck, G.m.b.H., in co-operation with Dr. E. Gassner of the "Service Endurance Laboratory," both at Darmstadt. A programme loading machine of this type for eight variable load levels, designated type PB 30/200, was supplied by W. and T. Avery, Ltd., Birmingham and installed in the "Bristol" Fatigue Laboratory well over a year ago, and sufficient experience has been gained with it since to give confidence in the practical potentialities of the testing principle for the execution of which it was specially designed.

Prerequisites for Programme Loading

Where random loading is encountered, the loading spectrum to which the design member is subjected is the basis from which life assessment must start, no matter what method is used. With programme loading, the determination of the spectrum is of added significance, because the test results are entirely a function of the applied spectrum, whereas with computational results variations in the spectrum are rather the reflected assumptions of the damage hypothesis employed. In the present context there is no need to pursue this argument further as it is evident that, to exploit the test method fully, the actual service spectrum must be known. Thus, for results of final validity, the prototype must be in operation, when strain recording devices, strain counters or other suitable instruments can be used for obtaining the spectrum.

The principle of evaluation of a random

* Head of Fatigue Laboratory, Bristol Aircraft Limited.

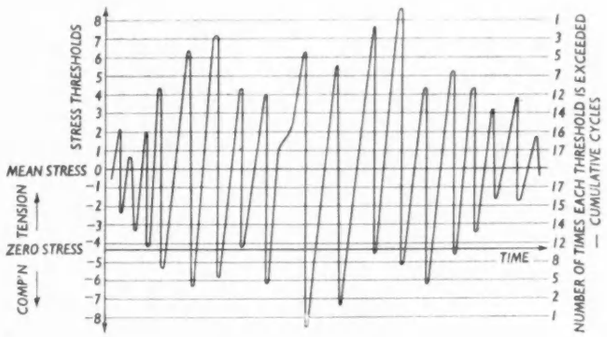

Fig. 2—Random loading record of stress against time

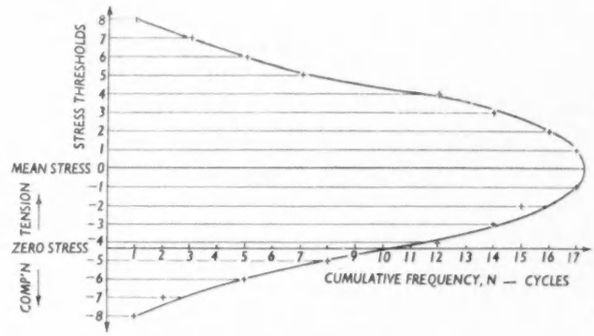

Fig. 3—Cumulative stress spectrum

strain record and its transformation into a spectrum is shown in Figs. 2 to 4. Let us suppose that an actual record of, say, ten seconds' duration is obtained on a design member as shown in Fig. 2 when the instrument measuring thresholds are expressed in terms of stress levels about the mean stress which is due to the unaccelerated weight imposed on the design member. If the numbers at which the wave trace reaches or exceeds each stress threshold are counted, the numbers of cumulative cycles for each threshold are obtained. The cycles are cumulative because, e.g. in counting the frequency at the highest stress threshold, all lower thresholds are traversed by the wave trace, and thus a continuous summation of cycles at each threshold takes place. By plotting the cumulative cycles against their respective stress thresholds (Fig. 3), the cumulative spectrum or summation spectrum is obtained. It will be noted that although the actual cycle counts above and below the mean stress differ slightly, the spectrum curve drawn is symmetrical about the mean stress. This simplification is generally adhered to whenever possible, but there are cases in which the upper and lower curve are distinctly different. The cumulative spectrum can also be visualised as the enveloping curve to a transformed wave trace in which all individual stress cycles follow each other in a descending order of magnitude.

The continuous curve in Fig. 3 must now be transformed into a stepped sequence of discrete stress levels which can be applied by the programme loading machine. This is shown in Fig. 4 ; a certain number of stress cycles of constant amplitude is associated with each step (stress level), the choice of which follows normal integrating practice. For explanatory reasons the wave trace in Fig. 2 was taken to represent an extremely short duration of time and, therefore, the applied cycles in Fig. 4 would contain fractions of cycles. To avoid this, the cycle scale was multiplied by ten, but, of course, in reality, the multiplier may be of the order of 10^6 if a spectrum to failure should be represented.

In most applications the high stresses are of infrequent occurrence while the low stresses are very frequent. It is therefore of great importance to carry out measurements over long periods so that the spectrum is a representative sample of the statistical stress-frequency distribution experienced during the lifetime of the design member. If that is done, the stress levels of the stepped spectrum of the type shown in Fig. 4, which is consistently descending, must be so intermixed that in effect they approach the mixing effect of random loading. Thus, by suitable choice of the frequency scale of the stepped spectrum and regrouping the cyclic stresses into an ascending - descending order (programme stages), the programme cycle is obtained (Fig. 5), in which the relative frequencies between the various programme stages are the same as they are between those of the corresponding stress levels in the spectrum. The programme cycle is then automatically and repeatedly applied by the testing machine until failure of the specimen. Normally, with twenty to thirty programme cycles to failure the mixing effect of random loading is fully simulated, but even at much lower multiples the error due to incomplete load mixing remains small. Due to the ascending-descending order of sequence, a programme cycle of eight stress levels consists, from the load mixing point of view, of fourteen different applications (Fig. 5). The number of programme cycles to failure, multiplied by the operational hours or distance covered that one programme cycle represents, gives the life of the specimen.

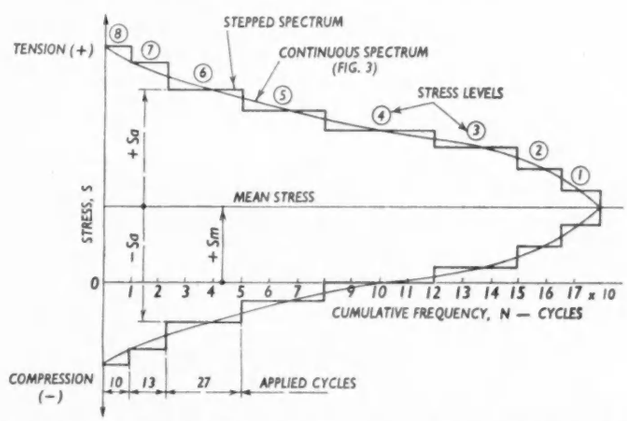

Fig. 4—Replacement of continuous stress spectrum by the equivalent stepped spectrum

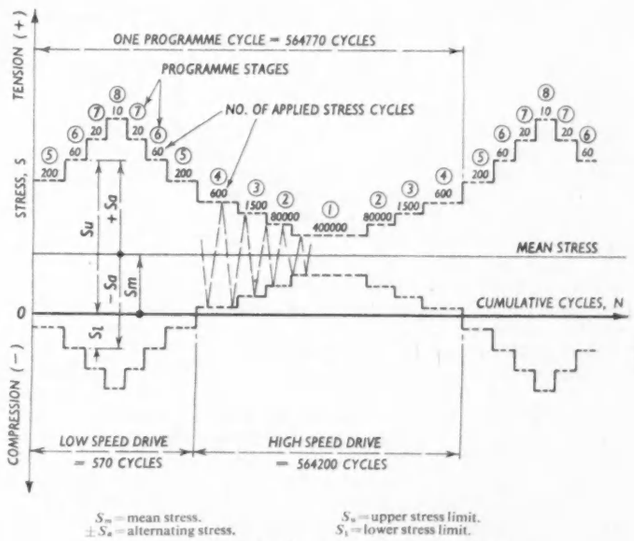

Fig. 5—The applied programme cycle pattern

Type Specification of the Testing Machine

The provision of eight programme stages was considered sufficient as tests have shown that for all spectra the load mixing effect was substantially obtained and a greater number of stages only prolonged the duration of testing and added unnecessarily to first cost and complexity. The cyclic speed was to be as high as possible, consistent with accurate control and response, and 3000 cycles per minute (c.p.m.) was fixed as maximum speed. However, as the higher or highest loads in the spectrum are of infrequent occurrence, only a few applications are called for per programme cycle (Fig. 5). This necessitated the provision of an additional low-speed drive, because the fast drive would use up more cycles to reach the desired high load and stabilise that level than there are cycles to be applied. The ratio of low to high-load maxima obtainable with these two drives was to be of the order of 2/3.

Another major requirement for realistic testing concerns the availability of large deflection amplitudes, be it to cater for very flexible components or to enable stucture testing to proceed under conditions of extensive crack propagation. This requirement was embodied in the basic machine of 30-ton loading capacity (metric tons have been used throughout this article). The magnitude of the deflection amplitude was to be such as to enable a six-fold load magnification to be applied by a system of levers in a special load-magnifying device for alternative use with

the basic unit ; as this could be achieved with the power input of the basic machine, the resulting deflection amplitude for magnified loads is only 1/6 of the input deflection. Therefore, to obtain large deflection amplitudes with the load-magnifying device, the input deflections had to be correspondingly larger. However, as specimens of very low flexibility would not normally exceed the 30-ton range, the maximum deflection amplitude chosen was, in fact, larger than that determined by load magnification requirements, i.e. of a maximum value of ±3·15in. The availability of large input deflections for direct load was to be utilised in bending and torsion or the combination of these loadings, and suitable attachments for applying such were therefore designed.

For accuracy of load measurement with both the basic and the magnifying units, two separate alternative loop dynamometers were required from which the control impulses were to be derived ; control for load amplitude constancy is thus obtained with a dynamometer attached to the fixed end of the machine, while the use of a deflection pick-up system in conjunction with the vibrating head makes control for constant deflection amplitudes possible. To enhance further the accuracy of applied loading, the dynamometer deflections were to be magnified optically and projected to a graduated glass screen adjoining the dynamometer.

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(To be continued)

Effect of Phosphorus on Intergranular Corrosion of Aluminium Brass*

By R. S. BEM, B.Sc., A.I.M.†

This article records the results of an investigation undertaken into the cause of intergranular attack in aluminium brass. The results indicate that the presence of more than 0·02 per cent of phosphorus makes the alloy susceptible to intergranular corrosion. The presence of as much as 0·1 per cent of arsenic can also encourage intergranular attack, but is less harmful than 0·03 per cent of phosphorus. Large grain size is found not to be harmful provided the phosphorus content is low.

DURING the past twenty years aluminium brass has more than proved its value as a tube material for condensers and other heat exchangers using sea and estuarine water for cooling. It is widely used in ships, in coastal power stations and the chemical and petroleum industries. The success of the material is due primarily to its high resistance to corrosion and to impingement attack in particular.

In reasonably clean sea water failures of aluminium brass tubes are extremely rare, but in heavily polluted water aluminium brass tubes occasionally suffer rapid perforation due to impingement attack, even at moderate water speeds, or to highly localised pitting. Aluminium brass in polluted sea water more commonly suffers widespread shallow pitting which is less damaging than the two types of attack already mentioned, but may still reduce considerably the life of the tube. This attack usually shows some tendency to proceed along grain boundaries, but slip planes and the grains themselves are attacked almost equally rapidly so that the rate of penetration along grain boundaries is not much greater than that of complete corrosion of the metal. This type of attack is illustrated in Fig. 1.

A more serious type of attack, which has occasionally been met in service, is purely intergranular and is usually associated with a very short life of the tube. This type of attack, which is illustrated in Fig. 2, has at different times been ascribed to a variety of factors, including the presence of arsenic (especially of more than 0·1 per cent) in the metal, large or heterogeneous grain size or the presence of specific contaminating agents in the sea water.

British Standards 378, 885 and 1464 all call for an arsenic content of between 0·02 and 0·06 per cent in aluminium brass, the arsenic being present to inhibit dezincification. A.S.T.M. designation B111–55 covers three aluminium brasses, which differ only in their dezincification inhibitor. Type B contains 0·02 to 0·10 per cent arsenic, type C contains 0·02 to 0·10 per cent antimony, and type D 0·02 to 0·10 per cent phosphorus. There is also a United States Department of Defence specification, MIL–T–16992A(–1), which calls for 0·02 to 0·1 per cent each of arsenic, antimony and phosphorus. The German specification SoMs 76 demands 0·02 to 0·06 per cent of phosphorus and/or arsenic as dezincification inhibitor. Concern with the effect of grain size is reflected in B.S. 1464, which specifies that aluminium brass tubes for the petroleum industry should have after annealing an average grain size not exceeding 0·025mm average diameter, with a maximum individual grain size of four times the average grain size, or 0·080mm, whichever is the greater. It will be clear from comparison of the above specifications that, whereas arsenic is almost always used as the dezincification inhibitor in aluminium brass made by British manufacturers, phosphorus is often used by European manufacturers, and arsenic, phosphorus or antimony may be used by manufacturers in the United States.

An investigation has been undertaken into the cause of intergranular attack in aluminium brass and the results of this have indicated that the presence of more than 0·02 per cent of phosphorus makes the alloy susceptible to intergranular corrosion. The presence of as much as 0·1 per cent of arsenic can also encourage intergranular attack, but is considerably less harmful than 0·03 per cent of phosphorus, and arsenic contents as high as this are, of course, outside the relevant British Standard specifications. Large grain

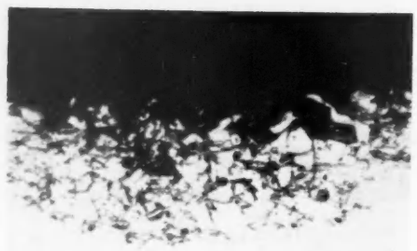

Fig. 1—Aluminium brass from service in polluted sea water. As 0·03 per cent, P nil. ×200

size was found not to be harmful provided that the phosphorus content was low, but appeared to increase the rate of intergranular penetration in alloys containing more than 0·02 per cent of phosphorus. Cold-worked aluminium brass shows a slight tendency to intercrystalline attack accompanied by attack along slip planes and into the bodies of the grains themselves, but if the phosphorus content is below about 0·02 per cent this intercrystalline attack is insignificant compared with the attack at slip planes.

Aluminium brass complying with the British Standards mentioned above should therefore be free from significant intergranular attack irrespective of grain size.

Most of the corrosion tests described in this article have been carried out in natural

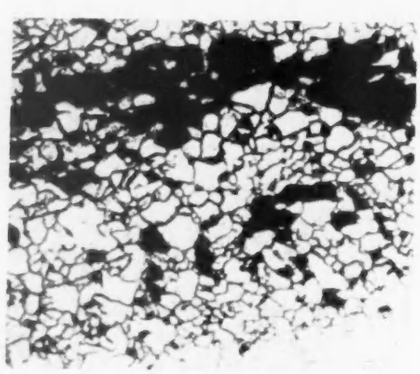

Fig. 2—Aluminium brass from service in polluted sea water. As 0·03 per cent, P 0·05 per cent. ×300

sea water to which hydrogen sulphide has been added, a large amount of the evidence having shown that such additions reproduce the aggressive characteristics of naturally occurring polluted waters. It has been found, however, that aluminium brass containing phosphorus may suffer intergranular attack in a variety of media.

MATERIALS TESTED

A number of aluminium brasses of different composition were tested, covering a range of

* The work described in this article was made available to members of the B.N.F.M.R.A. in confidential research reports issued in 1955 and 1956.

† Investigator, B.N.F.M.R.A., London.

arsenic contents from nil to 0·1 per cent and phosphorus contents from nil to 0·09 per cent. One alloy with 0·04 per cent of antimony was also tested. Analyses of all the alloys tested are given in Table I :

TABLE I—*Analyses of Aluminium Brasses Tested*

B.N.F. mark	Copper, per cent	Zinc, per cent	Aluminium, per cent	Arsenic, per cent	Phosphorus, per cent	Antimony, per cent	Iron, per cent
PHO	75·8	Remainder	1·86	0·020	<0·005	<0·002*	0·05*
RGA	75·3	Remainder	2·11	<0·003*	0·088	<0·002*	0·01*
RSF	76·0	Remainder	2·11	<0·003*	0·034	<0·002*	0·01*
RWG	77·8	Remainder	1·91	0·032	0·020	<0·002*	0·01*
RWH	77·8	Remainder	1·83	0·028	0·007	<0·002*	0·01*
RGC	75·4	Remainder	2·11	0·031	<0·0005	<0·002*	0·01*
SCM	75·7	Remainder	2·03	0·039	<0·0005	<0·002*	0·01*
RWF	76·4	Remainder	2·00	0·038	0·043	<0·002*	0·01*
RJK	75·6	Remainder	2·03	0·096	<0·0005	<0·002*	0·01*
RJL	75·6	Remainder	2·00	<0·003*	<0·0005	0·040	0·01*
RGB	75·3	Remainder	2·09	0·032	0·090	<0·002*	0·01*

* Spectrographic analysis

All these materials were prepared in the laboratory except PHO, which was a sample of commercial condenser tube. The copper content of several of the laboratory prepared materials was slightly below the B.S. limit (76 per cent) for copper, but the alloys were all single phase. The alloys were tested in the annealed condition (annealed fifteen minutes at 600 deg. Cent.) unless otherwise stated.

Method of Testing

Some of the tests were carried out in a slow rotor apparatus consisting of a glass tank holding 35 litres of sea water set in motion by a rotary paddle placed at the centre of a stationary disc. Twenty-four specimens were held vertically on the circumference of the disc, the speed of water past them being about 2ft to 3ft per second. Tests in semi-static conditions were made by suspending specimens from glass hooks in a tank containing 4 litres of sea water aerated by passing air through a sintered glass disc so that air bubbles did not impinge on the surface of the specimens, but the water was maintained in gentle motion. Tests under static conditions were carried out by suspending pairs of specimens in sea water in 500 c.c. flasks.

The rotor test specimens were 7cm by 2cm by 1·5mm thick. Those for static tests were slightly smaller. Corners and edges were rounded and the specimens cleaned with emery paper, degreased in acetone and weighed before testing. After testing they were examined with a low-power binocular microscope. Loose products were removed by brushing in water and they were then re-examined and reweighed. Several micro-sections of each specimen were then prepared and examined under high magnification. In two rotor tests, specimens in the form of miniature tensile test pieces were used, and the ratio of percentage loss of strength to percentage loss of weight taken as a quantitative estimate of intergranular corrosion.

Natural sea water was used for most of the tests, hydrogen sulphide being added to simulate conditions in polluted waters. One set of tests was carried out in clean sea water and the effects of certain other contaminants in natural sea water and in sodium chloride solution were also investigated.

Details and Results of Individual Tests

A preliminary test was carried out in which a specimen cut from a condenser tube which had suffered severe intergranular corrosion in service was tested in static sea water containing hydrogen sulphide, together with a number of other aluminium brasses that were available. Some of these were commercial tubes and others were laboratory-produced alloys. They varied in composition and grain structure, but all contained about 0·02 to 0·03 per cent arsenic and practically no phosphorus, whereas the sample from the tube which had corroded in service contained 0·05 per cent phosphorus, but practically no arsenic. This sample also had a rather large grain size (0·1mm to 0·2mm). The sample from the tube which had corroded in service suffered intergranular attack in this test, thus confirming the validity of the test conditions. No intergranular attack was shown by any of the arsenic-inhibited alloys in this test.

Test No. 1.—Alloys containing 0·09 per cent of phosphorus, alone or together with 0·03 per cent of arsenic, were tested together with phosphorus-free alloys containing 0·03 or 0·1 per cent of arsenic and one containing 0·04 per cent of antimony. Each material was prepared with two grain sizes (approximately 0·02mm and 0·2mm diameter),

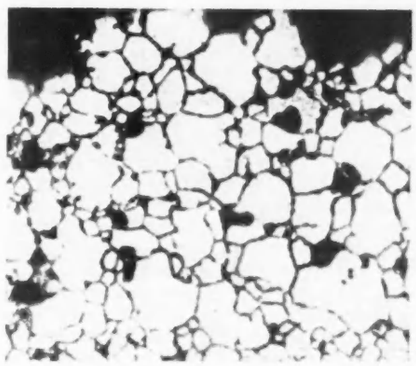

Fig. 3—Aluminium brass tested in laboratory in sea water containing hydrogen sulphide. As nil, P 0·03 per cent. ×250

duplicate specimens of each grain size being tested in semi-static conditions in aerated natural sea water to which 10 p.p.m. of hydrogen sulphide were added each day. One set of specimens was removed after four weeks ; the water in the tank was changed and the remaining set left on test for a further eight weeks. The results of the test are summarised in Table II :

TABLE II—*Test No.* 1 : *Specimens Immersed in Gently Moving Aerated Sea Water Containing Hydrogen Sulphide*

B.N.F. mark	Dezincification inhibitor	Average grain size (mm)	Depth of intergranular attack (mm)	
			4 weeks	12 weeks
RGA	0·088% P	0·022	0·12	0·30
		0·23	0·30	0·35
RGB	0·032% As 0·090% P	0·010	0·12	0·20
		0·25	0·25	0·50
RGO	0·031% As	0·029	Nil	Nil
		0·23	Nil	Nil
RJK	0·096% As	0·033	0·08*	0·05*
		0·15	Nil	Nil
RJL	0·040% SB	0·025	Nil	Nil
		0·19	Nil	Nil

* Attack not purely intergranular ; a few deeper transgranular cracks.

Both the alloys containing phosphorus suffered considerable intergranular penetration of the type illustrated in Fig. 3, the depth of penetration tending to be somewhat greater in the specimens having the larger grain size. The phosphorus-free alloys containing the standard quantity of arsenic or 0·04 per cent of antimony showed no intergranular corrosion, irrespective of grain size. The alloy containing 0·1 per cent of arsenic showed some tendency to intergranular attack, but was considerably less affected than the alloys containing phosphorus. The specimens of this alloy also showed a few, deeper transgranular cracks.

Tests Nos. 2 *and* 3.—In tests Nos. 2 and 3 an attempt was made to obtain a quantitative measure of the damage caused to aluminium brasses of different composition and grain size as a result of intergranular corrosion. Tensile test pieces $\frac{3}{16}$in wide by 1in gauge length were subjected to the rotor test in sea water to which 5 to 6 p.p.m. of hydrogen sulphide was added each working day. The ratio of the percentage loss of strength to the percentage loss of weight determined at the end of the test was taken as an estimate of severity of intergranular corrosion. Since corrosion of the surface of the specimen was not completely uniform the results of these

TABLE III—*Test No.* 2 : *Tensile Test Specimens After* 4 *Weeks' Rotor Test in Sea Water Containing Hydrogen Sulphide*

B.N.F. mark	Dezincification inhibitor	Average grain size (mm)	Percentage loss of strength	Percentage loss of weight	Ratios of percentage loss of strength to percentage loss of weight for triplicate specimens	Average ratios
RGA	0·088% P	0·027	7·3 13·7 24·4	1·8 1·8 2·2	4·0 7·8 11·2	7·7
		0·16	13·4 6·4 20·8	1·9 1·6 1·7	7·0 4·1 12·5	7·9
RSF	0·034% P	0·028	24·1 16·3 16·6	2·4 1·8 2·0	10·0 9·2 8·3	9·2
		0·11	20·4 19·9 21·6	2·0 2·2 2·1	10·0 9·0 10·0	9·7
RGC	0·031% As	0·045	1·2 8·6 5·4	2·1 1·8 1·6	0·6 4·7 3·3	2·9
		0·19	3·3 2·3 6·8	2·0 1·9 2·1	1·6 1·0 3·3	2·0
RJK	0·096% As	0·057	7·8 13·3 14·5	2·5 2·7 2·8	3·1 4·9 5·2	4·4
		0·24	5·5 7·3 6·9	2·3 2·6 2·0	2·4 2·8 3·5	2·9

TABLE IV—*Test No. 3 : Tensile Test Specimens After 5 Weeks' Rotor Test in Sea Water Containing Hydrogen Sulphide*

B.N.F. mark	Dezincification inhibitor	Average grain size (mm)	Percentage loss of strength	Percentage loss of weight	Ratios of percentage loss of strength to percentage loss of weight	Average ratios
RGA	0·088% P	0·050	31·2 31·8 31·1 33·0	2·4 2·1 2·3 2·6	13·0 15·1 13·5 12·6	13·5
RWF	0·043% P 0·038% As	0·050	26·3 27·7 28·9 29·3	2·7 2·7 3·2 2·2	9·7 10·2 9·0 13·3	10·5
RSF	0·034% P	0·065	37·4 37·2 48·4 35·8	3·6 2·9 3·0 3·0	10·3 12·8 16·1 11·9	12·7
RWG	0·020% P 0·032% As	0·089	18·2 16·2 14·0	2·6 2·5 2·4	7·0 6·4 5·8	6·4
RWH	0·007% P 0·028% As	0·064	9·3 13·4 14·3 19·4	3·0 2·7 3·4 2·7	3·1 4·9 4·2 7·1	4·6
RGC	0·031% As	0·081	13·4 14·6 13·1	3·2 3·2 2·9	4·1 4·5 4·5	4·3

tests are not quantitatively accurate, but they are considered to provide a reasonable estimate of the degree of intergranular attack suffered by the specimens. Details of the materials tested and the results of the tests are given in Tables III and IV.

In test No. 2, four alloys containing respectively 0·03 per cent phosphorus, 0·09 per cent phosphorus, 0·03 per cent arsenic and 0·09 per cent arsenic, were investigated, three large-grained and three small-grained specimens of each being tested for four weeks. The average ratio of percentage loss of strength to percentage loss of weight was about 8½ for the alloys containing phosphorus, but only about 3 for those containing arsenic. The ratio for the alloy containing 0·1 per cent of arsenic was slightly higher than for that containing 0·03 per cent, but the difference is probably not significant. The ratio obtained for any one material did not appear to be affected by grain size. Fig. 3 shows the intergranular attack produced on the alloy containing 0·034 per cent phosphorus.

In test No. 3 the alloys containing more than 0·03 per cent of phosphorus gave percentage loss of strength to percentage loss of weight ratios greater than 10, but the ratio did not vary systematically with the phosphorus content. The ratio was only about 6 for the alloy containing 0·02 per cent phosphorus and about 4½ for those with 0·007 per cent or no phosphorus.

Test No. 4 was carried out with specimens of the same materials as used for test No. 3, suspended in sea water in 500 ml. beakers under static conditions; 16 p.p.m. of hydrogen sulphide were added to the water in the beakers once a week and the water changed every fortnight. Sets of specimens were removed and examined after eight, sixteen and thirty-two weeks, each set consisting of two large-grained and two small-grained specimens of each alloy. An additional set of specimens was tested for thirty-two weeks in sea water without the addition of hydrogen sulphide. Detailed results of the test are given in Table V.

The specimens tested in sea water with hydrogen sulphide added suffered considerable uniform roughening of the whole surface. Intergranular attack occurred only on those containing 0·02 per cent or more of phosphorus and was more marked on those containing 0·03 per cent or more. Specimens with large grain size generally suffered deeper intergranular attack than corresponding specimens with small grain size, but this difference was not pronounced in some cases. The rate of advance of intergranular attack into the metal decreased with time, but the area affected by this type of attack increased. The rate of loss of weight also increased with time, indicating that the film formed on the aluminium brass in these tests was not protective, but actually increased the rate of attack on the metal.

The last two columns of Table V record the results for specimens tested for thirty-two weeks in sea water without hydrogen sulphide. These were in generally good condition, some showing only slight discoloration of the surface and none suffering an overall loss of weight greater than 1 mg per square centimetre. Certain specimens, however, developed considerable attack at the shielded area formed at their points of contact with the glass hooks from which they were suspended. This attack extended upwards from the chamfered edge of the suspension hole and its depth could not be measured with any accuracy. It is therefore recorded in the table as "slight," "moderate" or "severe," "severe" attack representing attack to a depth of about 0·5mm over an area of about 5 square millimetres. In the case of the alloys containing more than 0·03 per cent of phosphorus this attack was combined with intergranular corrosion deeper than that shown on the corresponding specimens tested in sea water containing hydrogen sulphide. No intergranular attack took place on shielded areas on specimens containing less than 0·03 per cent phosphorus.

Test No. 5.—In tests Nos. 1 to 4 all specimens were tested in the annealed condition and attack on the surface of the specimen was more or less uniform in the absence of intergranular attack. In the preliminary test, however, it was found that specimens cut from commercial arsenical aluminium brass tubes showed the type of attack commonly met in service in polluted waters, slip planes, grain boundaries and grains being attacked as shown in Fig. 1. In test No. 5, therefore, aluminium brasses of different phosphorus contents were compared in the annealed and worked conditions. Four laboratory-prepared materials were selected for this test, giving a range of phosphorus contents from 0 to 0·4 per cent, all with 0·02 to 0·04 per cent arsenic present. Two specimens of each material were tested in the annealed condition and two after reduction 20 to 25 per cent by cold rolling. Specimens from a commercial tube (PHO) containing 0·02 per cent arsenic, but no phosphorus, were also tested, two as received and two after annealing for fifteen minutes at 600 deg. Cent. Specimens were subjected to a rotor test in sea water containing hydrogen sulphide for a period of six weeks. The results are summarised in Table VI.

Two figures for depth of attack are included in this table. Column 7 records the maximum depth of gross pitting or local thinning as measured with a micrometer, while column 8 records the depth of intergranular attack or microscopic pitting, below the level of gross attack, as observed in microsections. The worked alloy containing 0·02 per cent phosphorus suffered attack at grain boundaries and along slip planes but the depth of intergranular attack was little greater than that of attack along slip planes or by pitting in the body of the grains. The three effects appeared to be of approximately equal importance.

TABLE V—*Test No. 4 : Static Water Test. 32 Weeks*

B.N.F. mark	Dezincification inhibitor	Average grain size (mm)	Tested in sea water with hydrogen sulphide added						Tested in clean sea water	
			Weight loss (mg/sq. cm.)			Depth of intergranular attack or micropitting* (mm)			Attack on shielded areas after 32 weeks	
			8 weeks	16 weeks	32 weeks	8 weeks	16 weeks	32 weeks	Degree of general attack	Depth of intergranular attack (mm)
R.G.A.	0·088% P	0·16	2·71	6·38	16·05	0·07	0·14	0·19	Very slight	0·72
		0·029	3·11	6·77	16·35	0·08	0·05	0·17	Moderate to severe	0·24
R.W.F.	0·043% P 0·038% As	0·18	2·66	6·83	18·42	Nil	Nil	0·13	Severe	0·48
		0·044	2·25	7·94	17·94	0·04	0·08	0·11	Moderate to severe	0·48
R.S.F.	0·034% P	0·14	2·40	6·68	16·70	0·11	0·12	0·20	Very slight	0·48
		0·021	2·66	8·06	17·66	0·02	0·08	0·09	Moderate	0·10
R.W.G.	0·020% P 0·032% As	0·18	3·27	8·69	25·89	Nil	Nil	0·09	Moderate to severe	Intergranular attack absent
		0·065	3·36	6·80	17·79	Nil	0·04	0·06	Slight	
R.W.H.	0·007% P 0·028% As	0·18	2·98	6·69	19·00	Nil	Nil	Micro-pitting 0·05	Slight to moderate	Intergranular attack absent
		0·056	3·57	7·68	22·28	Nil	Nil		Slight	
R.G.C.	0·031% As	0·16	3·56	7·02	21·11	Nil	Micro-pitting 0·05	Nil	Moderate to severe	Intergranular attack absent
		0·045	2·28	6·50	24·81	Nil		Nil	Moderate to severe	

* Micropitting = Production of pits too small to be seen except under the microscope.

TABLE VI—*Test No. 5: Results of 6 Weeks' Rotor Test in Sea Water Containing Hydrogen Sulphide*

B.N.F. mark	Dezincification inhibitor	Average grain size (mm)	Condition of alloy	Hardness (V.P.N.)	Weight loss (mg/sq. cm.)	Approximate maximum depth of attack as measured by micrometer from the original surface (mm)	Depth of intergranular attack or micropenetration below general level of corroded surface (mm)	Remarks
R.W.F.	0·043% P 0·038% As	0·023	Annealed	90	32·1	0·25	0·19	Intergranular attack
			Worked	181	25·9	0·30	0·13	Intergranular attack and some attack at slip planes
R.W.G.	0·020% P 0·032% As	0·045	Annealed	74	27·5	0·27	0·12	Isolated micropits starting at grain boundaries
			Worked	137	21·7	0·27	0·25	Slip planes and grain boundaries attacked
R.W.H.	0·007% P 0·028% As	0·040	Annealed	68	23·2	0·18	0·04	Micropitting
			Worked	151	21·5	0·18	0·12	Slip planes chiefly attacked
S.C.M.	0·039% As	0·045	Annealed	72	17·1	0·12	0·08	Micropitting
			Worked	155	21·4	0·19	0·08	Slip planes chiefly attacked
P.H.O.	0·020% As	0·031	Annealed	69	28·7	0·05	0·07	Micropitting
			Worked	189	19·8	0·05	0·12	Slip planes, grains and grain boundaries attacked

In the materials containing less than 0·02 per cent phosphorus, damage due to intergranular attack was less significant than that due to attack at slip planes and on the grains themselves. The difference in the form of corrosion in annealed and cold-worked specimens is shown in the photomicrographs Figs. 4 and 5, representing aluminium brass

Fig. 4—Alloy RWG. As 0·03 per cent, P 0·02 per cent. Annealed, V.p.n. 74. ×250

containing 0·02 per cent phosphorus and Figs. 6 and 7, representing commercial tube containing less than 0·005 per cent phosphorus. The specimens containing 0·04 per cent phosphorus suffered intergranular attack,

Fig. 5—Alloy RWG. As 0·03 per cent, P 0·02 per cent, cold rolled (20 per cent reduction), V.p.n. 137. ×250

similar to that shown in Fig. 3, in both the annealed and the worked conditions, the attack being slightly deeper in the former. The worked material showed also some attack at slip planes.

TESTS IN VARIOUS ENVIRONMENTS

Most of the tests described above were carried out in natural sea water, to which hydrogen sulphide was added, but the observation of intercrystalline corrosion at shielded areas on aluminium brass specimens containing phosphorus tested in clean sea water indicates that hydrogen sulphide is not essential for this type of attack to occur and suggests that whenever the conditions are particularly severe, the consequent corrosion

Fig. 6—Commercial tube PHO. As 0·02 per cent, P nil. Annealed V.p.n. 69. ×250

is likely to take the form of intercrystalline attack if the aluminium brass contains phosphorus.

Some tests were carried out with aluminium brass specimens containing 0·09 per cent phosphorus with and without 0·03 per cent arsenic and with phosphorus-free specimens containing 0·03 per cent arsenic, 0·1 per cent arsenic or 0·04 per cent antimony. The specimens were exposed for twelve weeks to static sea water, to which was added

Fig. 7—Commercial tube PHO. As 0·02 per cent, P nil. As received, V.p.n. 189. ×250

either 17 p.p.m. hydrogen sulphide, 35 p.p.m. hydrochloric acid, 60 p.p.m. nitric acid, 35 p.p.m. ammonia or 65 p.p.m. cystine. Intergranular attack was observed only on specimens exposed to sea water containing hydrogen sulphide or sea water containing nitric acid. In the latter case only those alloys containing phosphorus were affected; in the former the alloys containing phosphorus were seriously affected and the one containing 0·1 per cent arsenic was affected slightly.

A similar series of tests with the same materials was carried out in 3 per cent sodium chloride solution containing either 100 p.p.m. hydrogen sulphide or 200 p.p.m. of hydrochloric acid, nitric acid, sulphuric acid or ammonia. Intergranular attack was observed on the alloys containing phosphorus in all these solutions except in that to which ammonia had been added. The alloy containing 0·1 per cent of arsenic showed a slight tendency to intergranular attack in the same solutions but the depth of attack was in no case greater than 0·06mm.

CONCLUSIONS

Dezincification was not observed on any specimens in this programme of tests and it appears that arsenic, antimony and phosphorus are all effective inhibitors of dezincification of aluminium brass. The results give no reason to conclude that the resistance of the alloy to corrosion in the form of pitting, impingement attack or uniform thinning is affected by the dezincification inhibitor chosen. The results do show conclusively, however, that the presence of more than 0·02 per cent of phosphorus in the alloy greatly increases its liability to intergranular corrosion. Probably under most conditions of service intergranular corrosion is unlikely to take place, but attack of this type has been observed in aluminium brass tubes containing phosphorus which have been in service in sulphide-polluted sea water. The laboratory tests indicate that sulphide pollution is not essential for intergranular corrosion but that it may take place in almost any particularly corrosive conditions.

It is clearly preferable to use arsenic as dezincification inhibitor in aluminium brass (as is the normal British practice), or antimony rather than phosphorus. If the phosphorus content is kept below 0·02 per cent, significant intergranular attack is not observed either in large grain or small grain specimens.

ACKNOWLEDGMENT

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James Brindley Commemoration

By F. NIXON

An interesting ceremony took place in the hamlet of Tunstead in the parish of Wormhill, near Buxton, on November 1, when the tablet commemorating James Brindley, shown in the adjacent photograph, was unveiled by Mr. J. L. Longland, M.A., the Director of Education for Derbyshire. At the same time Miss Y. H. B. Hartford planted an ash tree a few yards away.

NEARLY 150 people attended a ceremony at Wormhill, near Buxton, on November, 1 and most of the organisations concerned with canals and canal history were represented, including the Bridgewater Department of the Manchester Ship Canal, the British Transport Commission, the Inland Waterways Association, the Railway and Canal Historical Society, the Inland Waterways Protection Society, and the Newcomen Society. A plaque commemorating James Brindley was unveiled. The plaque is illustrated herewith. After the unveiling, a wreath was placed on the memorial by a representative of the British Transport Commission, an unanticipated gesture which was greatly appreciated.

Tablet and tree are situated in a small field known as Brindley's Croft. In this field once stood the cottage in which James Brindley, " the Father of British Canals " was born in 1716. Until recently the site of the cottage was marked by a large ash tree, which was noted by Samuel Smiles in 1861 as then having a girth of 6ft 9in. This tree having blown down in a gale a few years ago, the Local History Section of the Derbyshire Archæological Society decided to erect the tablet. In this they were actively encouraged by Miss Hartford, whose paternal grandmother was a member of the Fleming family which has owned the croft since shortly after Brindley's death. A great-aunt of Miss Hartford's made the drawing which illustrates Smiles' " Life of James Brindley."

To mark the occasion, the Local History Section has produced a souvenir booklet, which has notes on Brindley's life. In preparing this booklet there came to light references to James Brindley which are felt to be little known, and which will be of especial interest to students of canal history. Most students will have read Samuel Smiles' " Life of James Brindley," which forms a large part of Volume I of his *Lives of the Engineers*. Smiles was fortunate in being able to obtain access to a number of Brindley's pocket notebooks, in which he kept records of his undertakings and transactions. This story is a most readable one, and it runs to some 170 pages. It has been taken as the source material for many of the subsequent writings on Brindley and his works.

The current search, however, has discovered a number of references by Brindley's contemporaries and near-contemporaries, all of much earlier date than Smiles. It is added testimony to the generally held views of Brindley's genius and generous character that all these references, with the exception of a slightly petulant report by Smeaton, were couched in the same appreciative terms as those which were used by Smiles and which set the subsequent pattern. It will serve to remind readers of the main events in the life of Brindley if the last reference is reproduced first. This is taken from a book of local topography which was published in 1795—*A Description of the Country from Thirty to Forty Miles Round Manchester*. The author was John Aikin, M.D., 1747–1822, who was better known for his *Evenings at Home*, a popular reader which was translated into almost every European language ; his *General Biography* ; and his editorship of *The Monthly Magazine*, 1796 to 1807.

His " Account of Mr. Brindley " is a fine example of succinct writing, and it is reproduced in full below :

" James Brindley was born at Tunsted in the parish of Wormhill, Derbyshire, in 1716. His father was a small freeholder, who dissipated his property in company and field-amusements, and neglected his family. In consequence, young Brindley was left destitute of even the common rudiments of education, and till the age of seventeen was casually employed in rustic labours. At that period he bound himself apprentice to one Bennet, a mill-wright, at Macclesfield, in Cheshire, where his mechanical genius presently developed itself. The master being frequently absent, the apprentice was often left for weeks together to finish pieces of work concerning which he had received no instruction ; and Bennet on his return was often greatly astonished to see improvements in various parts of mechanism of which he had no previous conception. It was not long before the millers discovered Brindley's merits, and preferred him in the execution of their orders to the master or any other workman. At the expiration of his servitude, Bennet being grown into years, he took the management of the business upon himself ; and by his skill and industry contributed to support his old master and his family in a comfortable manner.

" In process of time, Brindley set up as a mill-wright on his own account, and by a number of new and ingenious contrivances greatly improved that branch of mechanics, and acquired a high reputation in the neighbourhood. His fame extending to a wider circle, he was employed in 1752 to erect a water-engine at Clifton, in Lancashire, for the purpose of draining some coal-mines. Here he gave an essay of his abilities in a kind of work for which he was afterwards so much distinguished, driving a tunnel under ground through a rock nearly 600 yards in length, by which water was brought out of the Irwell for the purpose of turning a wheel fixed thirty feet below the surface of the earth. In 1755 he was employed to execute the larger wheels for a silk mill at Congleton ; and another person, who was engaged to make other parts of the machinery, and to superintend the whole, proving incapable of completing the work, the business was entirely committed to Brindley ; who not only executed the original plan in a masterly manner, but made the addition of many curious and valuable improvements, as well in the construction of the engine itself, as in the method of making the wheels and pinions belonging to it. About this time, too, the mills for grinding flints in the Staffordshire potteries received various useful improvements from his ingenuity.

" In the year 1756 he undertook to erect a steam-engine upon a new plan at Newcastle-under-Line ; and he was for a time very intent upon a variety of contrivances for improving this useful piece of mechanism. But from these designs he was, happily for the public, called away to take the lead in what the event has proved to be a national concern of capital importance—the projecting the system of canal navigation. The duke of Bridgewater, who had formed his design of carrying a canal from his coal-works at Worsley to Manchester, was induced by the reputation of Mr. Brindley to consult him on the execution of it ; and having the sagacity to perceive, and strength of mind to confide in, the original and commanding abilities of this self-taught genius, he committed to him the management of the arduous undertaking. The nature and progress of this enterprise have already been described ; it is enough here to mention, that Mr. Brindley, from the very first, adopted those leading principles in the projecting of these works, which he ever afterwards adhered to, and in which he has been imitated by all succeeding artists. To preserve as much as possible the level of his canals, and to avoid the mixture and interference of all natural streams, were objects at which he constantly aimed. To accomplish these, no labour and expense was spared ; and his genius seemed to delight in overcoming all obstacles to them by the discovery of new and extraordinary contrivances.

" The most experienced engineers upon former systems were amazed and confounded at his projects of aqueduct bridges over navigable rivers, mounds across deep valleys, and subterraneous tunnels ; nor could they believe in the practicability of some of these schemes till they saw them effected. In the execution, the ideas he followed were all his own, and the minutest, as well as the greatest, of the expedients he employed, bore the stamp of originality. Every man of genius is an enthusiast. Mr. Brindley was an enthusiast in favour of the superiority of canal navigations above those of rivers ; and this triumph of art over nature led him to view with a sort of contempt the winding stream, in

The inscription on the plaque illustrated above reads :

JAMES BRINDLEY.
1716–1772
MILLWRIGHT AND CIVIL ENGINEER

Here stood the cottage in which James Brindley was born.
Of humble birth, he became famous as the pioneer builder of the great canals of England.
This plaque was erected by the Local History Section of the Derbyshire Archæological Society and unveiled by J. L. Longland, Esq., M.A., on November 1, 1958, when Miss Y. H. B. Hartford planted the adjacent ash tree.

which the lover of rural beauty so much delights. This sentiment he is said to have expressed in a striking manner at an examination before a committee of the House of Commons, when on being asked, after he had made some contemptuous remarks relative to rivers, what he conceived they were created for :—he answered, ' To feed navigable canals.'—A direct rivalry with the navigation of the Irwell and Mersey, was the bold enterprize of his first great canal ; and since the success of that design, it has become common all over the kingdom to see canals accompanying with insulting parallel the course of navigable rivers.

"After the successful execution of the duke of Bridgewater's canal to the Mersey, Mr. Brindley was employed in the revived design of carrying a canal from that river to the Trent, through the counties of Chester and Stafford. This undertaking commenced in the year 1766 ; and from the great ideas it opened to the mind of its conductor, of a scheme of inland navigation which should connect all the internal parts of England with each other, and with the principal seaports, by means of branches from this main stem, he gave it the emphatical name of the Grand Trunk. In executing this, he was called upon to employ all the resources of his invention, on account of the inequality and various nature of the ground to be cut through : in particular, the hill of Harecastle, which was only to be passed by a tunnel of great length, bored through strata of different consistency, and some of them mere quicksand, proved to be a most difficult as well as expensive obstacle, which, however, he completely surmounted. While this was carrying on, a branch from the Grank Trunk to join the Severn near Bewdley was committed to his management, and was finished in 1772. He also executed a canal from Droitwich to the Severn; and he planned the Coventry canal, and for some time superintended its execution, but on account of some difference in opinion, he resigned that office. The Chesterfield canal was the last undertaking of the kind which he conducted, but he only lived to finish some miles of it. There was, however, scarcely any design of canal-navigation set on foot in the kingdom during the latter years of his life in which he was not consulted, and the plan of which he did not either entirely form, or revise and improve. All these it is needless to enumerate, but as an instance of the vastness of his ideas, it may be mentioned, that on planning a canal from Liverpool to join that of the duke of Bridgewater at Runcorn, it was part of his intention to carry it by an aqueduct bridge across the Mersey, at Runcorn-gap, a place where a tide sometimes rising fourteen feet rushes with great rapidity through a sudden contraction of the channel. As a mechanic and engineer he was likewise consulted on other occasions ; as with respect to the draining of the low lands in different parts of Lincolnshire and the Isle of Ely, and to the cleansing of the docks of Liverpool from mud. He pointed out a method which has been successfully practised, of building sea-walls without mortar; and he was the author of a very ingenious improvement of the machine for drawing water out of mines by the contrivance of a losing and a gaining bucket.

"The intensity of application which all his various and complicated employments required, probably shortened his days ; as the number of his undertakings, in some degree, impaired his usefulness. He fell into a kind of chronic fever, which, after continuing some years with little intermission, at length wore out his frame, and put a period to his life on September 27th, 1772, in the 56th year of his age. He died at Turnhurst, in Staffordshire, and was buried at New Chapel in the same county.

"In appearance and manners, as well as in acquirements, Mr. Brindley was a mere peasant. Unlettered and rude of speech, it was easier for him to devise means for executing a design, than to communicate his ideas concerning it to others. Formed by nature for the profession he assumed, it was there alone that he was in his proper element ; and so occupied was his mind with his business, that he was incapable of relaxing in any of the common amusements of life. As he had not the ideas of other men to assist him, whenever a point of difficulty in contrivance occurred, it was his custom to retire to his bed, where in perfect solitude he would lie for one, two, or three days, pondering the matter in his mind, till the requisite expedient had presented itself. This is that true inspiration, which poets have almost exclusively arrogated to themselves, but which men of original genius in every walk are actuated by, when from the operation of the mind acting upon itself, without the intrusion of foreign notions, they create and invent. A remarkably retentive memory was one of the essential qualities which Mr. Brindley brought to his mental operations. This enabled him to execute all the parts of the most complex machine in due order, without any help of models or drawings, provided he had once accurately settled the whole plan in his mind. In his calculations of the powers of machines, he followed a plan peculiar to himself ; but, indeed, the only one he could follow without instruction in the rules of art. He would work the question some time in his head, and then set down the result in figures. Then, taking it up in this stage, he would again proceed by a mental operation to another result ; and thus he would go on by stages till the whole was finished, only making use of figures to mark the several results of his operations. But though, by the wonderful powers of native genius, he was thus enabled to get over his want of artificial method to a certain degree, yet there is no doubt, that when his concerns became extremely complicated, with accounts of various kinds to keep, and calculations of all sorts to form, he could not avoid that perplexity and embarrassment which a readiness in the processes carried on by pen and paper can alone obviate. His estimates of expense have generally proved wide of reality ; and he seems to have been better qualified to be the contriver, than the manager, of a great design. His moral qualities were, however, highly respectable. He was far above envy and jealousy, and freely communicated his improvements to persons capable of receiving and executing them ; taking a liberal satisfaction in forming a new generation of engineers able to proceed with the great plans in the success of which he was so deeply interested. His integrity and regard to the advantage of his employers were unimpeachable. In fine, the name of Brindley will ever keep a place among that small number of mankind, who form eras in the art or science to which they devote themselves, by a large and durable extension of their limits."

The amused contempt with which almost everyone greeted Brindley's proposal to carry the Bridgewater Canal over the River Irwell is well known, and it must have been some consolation to him when Smeaton reported favourably on his proposed route for a canal from Wilden Ferry, on the River Trent, to King's Bromley, in 1761, in the following words :—"(it is) well chosen . . . Mr. Brindley having judiciously designed the course." After the early difficulties, when his only supporter was the Duke of Bridgewater, it must have been even more gratifying to receive such adulatory notices as that of Arthur Young who wrote in 1768, in his *A Six Months' Tour through the North of England*, " The effect of coming at once on to Barton Bridge, and looking *down* upon a large river, with barges of great burden towing along it, and *up* another river, hung in the air, with barges sailing upon it, form together a scenery somewhat like enchantment. The number of foreigners who have visited the Duke of Bridgewater's present navigation is surprising."

Such praise, which was by now widespread, would turn the strongest head just a little, and this may be the reason for the note of mild asperity which has crept into the report by Smeaton, in 1768, on the proposals put forward by Brindley, Yeoman, and Golborne, for the Forth–Clyde Canal.

" As no difficulty is too great for Mr. Brindley, I should be glad to see how he would stow a fire-engine cylinder cast at Carron, of 6½ feet diameter, in one of his seven feet boats, so as to prevent it breaking the back of the boat, or oversetting," and again, in the same review, " . . . but pray, Mr. Brindley, is there no way to do a thing right but the way you do ? I wish you had been a little more explicit on the many accounts ; I think you only mention one, and that is to give more time to examine the two ends ; but pray, Mr. Brindley, if you were in a hurry, and the weather happened to be bad, so that you could not satisfy yourself concerning them, are the works to be immediately stopped when you blow the whistle, till you can come again, and make a more mature examination ? "

However, Brindley's inherent commonsense and his continued struggles with man as much as with natural forces appear to have restored his balance, for in 1776, four years after his death, we find William Bray, writing in his *Sketch of a Tour into Derbyshire and Yorkshire* : " It was the duke's great happiness to meet with a man of Mr. Brindley's genius, which broke out like the sun from a dark cloud, he having been totally destitute of education," and of the Bridgewater canal he writes : " These undertakings are truly stupendous, and strongly mark the spirit of enterprise which is so much the character of the present age." Of the man himself, Bray said : " Nor did Mr. Brindley, with a littleness too common, endeavour to conceal his discoveries in mechanics ; he has readily made them public, and has reared men whose abilities are now distinguished." In the following year, 1777, John Golborne, the civil engineer who had improved the navigation of the Clyde in 1770, and who had been a partner of Brindley's in the Forth–Clyde canal venture, referred to " That Great Genius, Mr. Brindley."

Finally, although it has been so widely reproduced in his " Life of James Brindley " what Smiles wrote nearly 100 years ago is so appropriate to present-day conditions that it may without excuse be quoted once again : " . . . we doubt whether mere hard work ever killed any man, or whether Brindley's labours, extraordinary though they were, would have shortened his life, but for the far more trying condition of the engineer's vocation—irregular living, exposure in all weathers, long fasting, and then, perhaps, heavy feeding when the nervous system was exhausted, together with habitual disregard of the ordinary conditions of physical health. These are the main causes of the shortness of life of most of our eminent engineers, rather than the amount and duration of their labours."

Rural Sites for Engineering Firms

By C. D. HARBURY*

In the years 1954–57 the author was in charge of a study into labour efficiency in factories in rural areas conducted at the University College of Wales, Aberystwyth. The full results have been published in book form—"The Industrial Efficiency of Rural Labour," by C. D. Harbury (University of Wales Press, 1958). The study was carried out with the aid of a grant made available under the Conditional Aid Scheme for the use of Counterpart Funds derived from the United States Economic Aid. Broadly, the conclusion drawn might be said to be that rural workers can hold their own for output against workers in industrial areas.

THERE are many small firms in engineering which the Americans describe as "footloose"—meaning by this that they are not securely wedded, technically or economically, to any specific geographical location. Such firms are liable to a variety of pressures to shift their place of business. Local authorities in London and other densely populated conurbations encourage them to leave the industrial districts, while authorities in certain smaller towns and rural areas try to entice them to move into their own parts of the country. The central government also encourages decentralisation.

There has been no attempt to conceal what might be called the social aims behind these policies. The main industrial centres are overcrowded and there are a large number of small and declining towns and villages whose future might be assured by the advent of some light industry. They are aims, moreover, which are generally acceptable to a great many people, though little thought is often given to the costs involved in following them through. This is doubly unfortunate. For not only is it then impossible to decide realistically whether or not such policies should be continued, but their very chances of success are much more likely to turn upon individual assessments of the relative costs of working in different places than upon anything else.

From this point of view there must be something to be said on both sides. A kind of balance sheet could be drawn up of the pros and cons of factory operation in the traditional locations and in isolated and new districts, setting out, for example, things like crowded premises, pressure on wage rates and traffic congestion against items such as more difficult transportation and communications and a scarcity of skilled labour.

Of course the list is not comprehensive. Even if it were it would be scarcely useful unless some numerical values were attached to the individual items, and these it must be recognised are likely to vary considerably for different places and for firms in different lines of business. It is reasonable to expect any firm contemplating such a move to make its own assessments. But it is often extremely hard to make any useful estimate of the costs of working somewhere else until the move has actually taken place.

In the case of no item is this likely to be more true than in the estimation of direct labour costs. Moreover, without first-hand knowledge of the efficiency of the local labour supply, it may even be difficult to guess whether labour quality should appear on the balance sheet as a credit or as a debit.

The Experience of Firms Already in the Country

Fortunately, things are not as bad as all that. Quite a number of engineering firms are already established in country districts. Some went during the war, when they were bombed out of their premises in the cities, and others were dispersed as a result of government policy. Moreover, when hostilities ceased, many of these firms preferred to remain in the country than to return to the scramble for labour and premises that continued in the industrial centres. Indeed, the advantages of rurally located factories were strong enough to attract more firms to leave the towns.

Rural Wales was a particularly suitable reception area, into which it is known that at least thirty engineering establishments entered between 1939 and 1956, and an investigation into their experience with regard to the efficiency of labour has recently been carried out at the University College of Wales, Aberystwyth. The investigation employed the method of case study. Factories working in rural Wales were first approached with a view to selecting processes where work could fairly easily be measured, and the co-operation was then sought of firms in one or other of the established industrial centres where comparable processes were being performed.

Matching operations in this manner was at some times a great deal easier than at others. It was occasionally assisted by the existence of parent firms with branches in country districts, but often involved extensive searches which even occasionally had to be abandoned without success.

Problems to be Solved

Even when relatively satisfactory matches were obtained, many problems remained to be solved. Thus there were matters connected with the statistical techniques to be used to average the recorded efficiencies of different operatives, of the same operatives at different times, and of slight variations in product type. In the absence of any unambiguous "best" way of doing any of these things a variety of methods were used; positive conclusions being drawn only when all pointed, at least roughly, in the same direction.

The principal other problem was how to measure operative efficiency at all. Two broad alternatives suggested themselves—to make direct observations of men and women at work by means of standard time-study techniques, or to use the records of previous output maintained by firms. Neither method can be said to be without any disadvantages. But it was decided to rely upon past output records, largely because they could be more broadly based—covering more operatives and much longer periods of time than can reasonably be expected by direct observation. It was also considered vital that the efficiency comparisons should not be limited to matters of mere technical prowess, but that the ability or inability to maintain high and steady levels of output over long periods should be allowed to play its part in the assessments.

Finally, it will be realised that perfect matches are in practice never found. The absolutely identical conditions needed for completely unambiguous comparisons of labour efficiency do not exist, nor can they be artificially created. Within the limits of very close matches, therefore, it was still necessary to ensure that every material difference in circumstances surrounding the workers compared received attention and was, as far as possible, allowed for. All the case studies were, therefore, prepared in a standard form, particular attention being paid to :

(i) Age, sex and experience of the workers.

(ii) Work method and layout, machines, tools and quality of product.

(iii) Level and method of remuneration, working conditions, amenities, hours of work, management and industrial relations.

The entire investigation into rural labour efficiency embraced workers engaged in twenty-five processes in factories covering a fairly wide range of manufacturing business and including several in the engineering industry. Before looking at the general conclusions, however, it may be useful to illustrate the nature of the comparisons by examining one particular study in a little detail.

Case Study

In one case study the co-operation was obtained of a large firm manufacturing a range of what, to preserve its anonymity, must be described as metal products. At the time, this firm operated a main factory situated in the West Midlands conurbation. Shortly after the end of the war it was decided for a variety of reasons to open a branch in a vacated wartime factory situated in a small country town. The population of the town was of the order of 5000, and it lay well over 50 miles from the nearest industrial centre.

The rural branch was smaller than the parent, but was, nonetheless, of fair size and employed about 600 workers. These were almost exclusively local as far as the general run of floor labour was concerned. The direction, on the contrary, was almost exclusively imported from the parent works, and only one foreman was a local after ten years' operation.

Division of labour between the factories appeared to be based largely upon a division of markets between them. The rural branch resembled a miniature of the original, therefore, rather than a part thereof, and a great deal of similar work was undertaken. In the case of six operations this similarity was adjudged to be close enough for valid efficiency comparisons.

(1) *Enamelling*, the manual roller painting of certain components.

(2) *Assembling* of a number of small identical parts in a simple jig using a spanner.

(3) *Filing* of steel tubes by hand.

(4) *Polishing* of steel tubes on polishing bobs.

(5) *Adjusting* components (assembled in (2) above) in another simple jig, judgment by eye being here satisfactory, the finished article being subjected to more rigorous inspection at a later stage of the manufacturing process.

(6) *Team Assembling*, moderately heavy assembly work by teams of six or seven operatives, working mainly with hammers, vices and punches, but also including jigs and drilling machines.

The findings are set out in summary form in the accompanying table. It can be seen that the efficiency of the rural workers (as

* Lecturer in Economics in the University of Birmingham.

Efficiency in Two Engineering Factories in a Rural and an Industrial Area

Operation	Number of workers		Average age (years)		Length of service (years)		Rural efficiency as per cent of industrial (within the range)
	Rural	Industrial	Rural	Industrial	Rural	Industrial	
Enamelling	9	16	27	29	4·2	5·6	127 to 149
Assembling	17	8	23	25	2·5	0·8	132 to 147
Filing	9	8	35	36	2·4	6·0	80 to 94
Polishing	5	6	41	35	6·6	17·7	115 to 121
Adjusting	11	15	40	39	5·9	16·0	111 to 112
Team assembling	7	8	22	41	2·1	10·8	95 to 129

measured by the fraction of output divided by time worked) was quite clearly higher than that of their industrial counterparts in four out of the six operations covered in the comparison. Furthermore, the same may be said almost as definitely of one more operation (team assembling), where the balance of advantage in all but one of the five statistical methods employed also substantially favoured the workers in the country.

In attempting to account for this differential, regard was paid to several possible causal factors. Of particular concern is the matter of experience on the job. This did differ somewhat from factory to factory, but was on average actually less in the rural works. Moreover, none of the five operations could be called highly skilled and separate comparisons made between groups of operatives classified according to length of service did not disturb the general pattern.

On the other hand, in the sole case of the third process, where the industrial workers showed up better than the rural, it is possible that a skill factor was at least partly responsible. It is perhaps no coincidence that filing was the one operation which the managing director instanced at the very first interview, and before any efficiency comparisons had been made, as an example of a difficulty experienced in persuading rural workers to acquire the knack of doing certain jobs.

A further rather remarkable difference in the performance of the two groups of workers was in the observed variations in the efficiency of individual workers inside each factory (not brought out in the table). In all (three) cases where details of output were separately available by operative, there was little substantial difference between the performance of individual workers in the city, whereas the range of efficiency of the rural operatives was spread much more widely. No firm evidence could, however, be obtained of the extent to which these results reflected less conscious or automatic joint output regulation among rural workers, or were due to inherent differences in what could be expected from the two types of labour.

Results of the Whole Investigation

The findings in the case study outlined above may, in some respects, be considered typical, but it is important to point out that others produced quite different results. In some the rural workers outshone industrial, in some the reverse was true, and in still others no significant differences in efficiency were found.

Thus, in half a dozen operations in two electrical engineering factories the industrial workers appeared on balance to be the better. In a welding process elsewhere, country girls paid by the hour put up a performance comparable to that of men working on a direct piece-rate system in a big industrial city. And in a study involving two branches manufacturing a range of wood and metal products, rural workers appeared better on some processes and worse on others.

When extended to include operations in other industries (hosiery, clothing, leather, bricks, &c.), the most striking feature of the results is, indeed, just this lack of any clear pattern in favour of either group of workers. Of the twenty-five processes under consideration, ten revealed higher rural efficiency (five considerable and five slight), the same number showed the opposite (three considerable and seven slight), and five pointed to broadly equal efficiencies.

Some attempt was made to ascertain the part played by skill in the comparisons. But it will be recalled that the choice of operations was restricted to those where work could be fairly easily measured and, to that extent, all are more or less repetitive. However, seven operations (including filing) might be said to have called for rather more skill than others, and the results in these do, in fact, suggest that rural workers may show up relatively less well. A number of managers interviewed gave this, too, as their personal opinion. But it must not be overlooked that rural workers did as well as industrial on some skilled jobs, and their relatively poor showing on others might reflect inappropriate management techniques.

Conclusion

Certain indirect evidence was obtained in the course of the investigation into rural labour efficiency, such as rates of labour turnover and of absence, and the opinions of management experienced in working with both types of labour. Together with the results of the direct efficiency comparisons, all the evidence confirmed that rural workers were able to hold their own over a wide field—given tolerable working conditions and management, and even occasionally with lower financial incentives and longer hours of work.

From the viewpoint of completing the balance sheet of pros and cons of rural factory operation with which this discussion started, however, it is also necessary to take account of the manner in which labour efficiency is reflected in the financial costs of operation. Generalisations here may be dangerous. But it may at least be observed that wage rates were sometimes lower in the country than in the town, if often broadly the same. And the occasional employment of rural women on jobs done by men in the older industrial centres could clearly be an important cost influence. Again, the cost of similar rates of labour turnover may not be the same in town and country if replacements are not always obtained and trained at the same speed. During the period covered by the inquiry it is fair to say that unskilled replacements were much more quickly obtained in most country factories. On the other hand, training facilities in industrial skills were sadly lacking over the greater part of the area, and many firms relied on importing their key personnel from the cities.

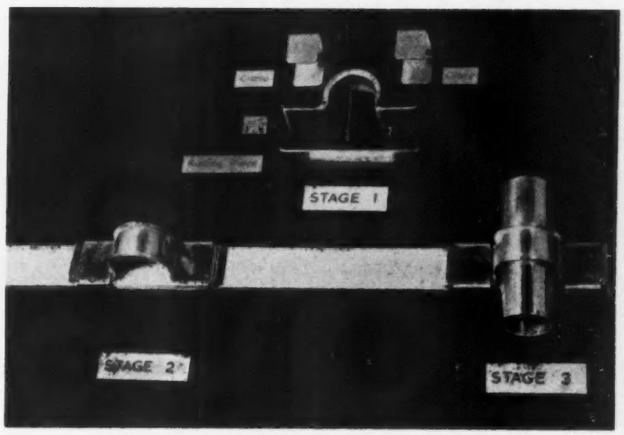
The decision to set up a rural factory should, of course, only be taken by an individual firm after careful consideration of all cost items, many of which (like transport and communication) have scarcely been mentioned here. But there must be a lot of engineering firms for which a country location might represent a sizeable financial advantage. If any have been held back by doubts concerning the efficiency of rural labour on the general run of factory jobs, then the results of the investigation described here should make them think again.

Pipe Clips

A new design of boltless pipe clip, which has been developed by Charlton, Weddle and Co., Ltd., Manors Works, Newcastle upon Tyne, is primarily intended for assembling heating coils, but is considered to offer a quick and economic alternative in other applications to the orthodox clip and rubbing piece assembled with bolts and nuts. The clip is applied with a special hand-operated closing tool, and its component parts and method of assembly can be seen in the illustration below. In application the tube is placed in position on the rubbing piece on the bearer bar. The clip is then placed over the tube and the clamp pieces closed in over its two sides and round the bar to lock the clip, rubbing piece and tube in position.

The makers point out that with the new clips nuts and bolts are dispensed with entirely, thus preventing the danger of their corrosion, and the constant check for working loose of nuts and bolts due to coil vibration. No marking off or drilling of holes for clips is necessary, and heating coils can be laid out on the bearer bars and clipped and fastened by the same workman. If silver-soldering of joints is needed, the clips hold the heating coils firmly for the operation. A clip can only be removed by a special tool.

The clips are being produced to fit bearer bars 1½in wide and where bars wider than this are installed bolted clips would need to be used. Aluminium brass strip is used for making clips for installation with aluminium brass heating coils and clips of aluminium alloy are being provided for heating coils made of the same metal, to prevent bi-metallic corrosion. Insulation of the clip assembly from the steel bearer bar is effected in these cases by laminating sheet "Fluon" to the base of the rubbing piece. The dimensions of the "Fluon" insulating pad are such that when the clip is fixed in position, the whole of the bearer bar in way of the clip is competely shielded on the top and undersides. To provide a leak-off for static electricity a number of the "Fluon" pads are carbon filled to give known resistance value. Mild steel clips for use with steel heating coils provide no mechanical or insulation problems.



Components and assembly of the boltless pipe clip

Notable British Locomotives of 1908

By E. C. POULTNEY, O.B.E.

No. I

CONTINUING the series of articles previously contributed to the columns of THE ENGINEER, reminiscent of locomotive practice half a century ago, I have selected as representing interesting developments in the year 1908 several noteworthy examples, signalling steps forward in British locomotive engineering. When recalling events taking place during the year under review, there is little doubt that the completion at Swindon of G. J. Churchward's famous engine No. 111, "The Great Bear," the first of the "Pacific" or 4–6–2 type to be placed in service on a British railway, can justly claim prior notice. Coincident with this outstanding development, further engines of the four-cylinder "Star" class were also turned out of the Swindon Works, and the design of superheaters also received further attention.

Turning to Doncaster, H. A. Ivatt, following the example set by G. Hughes and Churchward in 1906, fitted one of his standard 0–8–0 heavy freight engines, No. 417, with the Schmidt type of flue tube superheater, and D. E. Marsh at Brighton brought out a new and interesting design of 4–4–2 type tank engine for passenger service on the Brighton Line, also equipped with a Schmidt type superheater. At Horwich, Geo. Hughes took a further step in the fitting of flue tube superheaters by reconstructing some of Aspinall's 4–4–0 type passenger engines with boilers fitted with Schmidt superheaters and further distinguished by being provided with Walschaerts valve gear for the piston valves for the inside cylinders. This in itself was a distinct innovation in practice at Horwich, where, hitherto, Joy's valve gear had long been a firmly entrenched standard. Other events at Horwich included the introduction of some large tank engines built for "banking" purposes, and the building of an entirely new locomotive of the 4–6–0 type with four cylinders intended for the heaviest passenger services and also suitable for working fast freight trains as required.

For passenger traffic on the North Eastern Railway, Wilson Worsdell brought out an exceptionally fine design of the 4–4–0 type, having a large boiler carrying a higher working steam pressure than had been generally employed on that railway. These were amongst the largest engines of the type in the country and a particularly pleasing design. At the Derby Works of the Midland Railway, a remarkable locomotive made its appearance, designed and constructed in accordance with the ideas of Cecil Paget, later Sir Cecil Paget, who was Works Manager at Derby under R. M. Deeley, Locomotive Superintendent. This locomotive was unique not only in its conception, but also on account of the fact that its construction was practically entirely financed by its originator.

At Nine Elms, D. Drummond built for the London and South Western a further 4–6–0 four-cylinder design similar to others of the same type, but modified in respect to the size of the boilers and with smaller cylinders.

With the foregoing introductory notes, it is now proposed to review these developments in British locomotive practice of fifty years ago.

CHURCHWARD'S GREAT WESTERN ENGINES

Commencing with Churchward's locomotives built for the Great Western, those turned out of the Swindon shops in 1908 include : (1) the "Pacific" design No. 111, "The Great Bear," (2) further 4–6–0 four-cylinder engines of the "Star" class, of which No. 4001, "Dog Star" of 1907 was the first ; (3) a new 4–4–0 locomotive, designated the "Flower" class, intended for lighter duties on sections of the line not suitable for the larger and heavier engines ; and (4) further developments in the design of superheaters.

The famous engine, "The Great Bear," a photograph and drawing of which are reproduced in Figs. 1 and 2, marked a considerable advance in the size and power of locomotives so far built for passenger services on a British railway, and for this reason naturally attracted much attention. Basically, it was for all practical purposes a replica of the "Star" class so far as the arrangement of the four simple expansion cylinders with the attendant motion parts and Walschaerts valve gear were concerned, and the same may also be said of the main framing, the leading four-wheeled bogie and other details. At the trailing end, the standard type of frame was extended by a form of slab construction to carry the wide firebox and provide for a single pair of carrying wheels, the axle journals running in radial axleboxes generally similar to the Webb design as used on the London and North Western Railway. It was, however, the large boiler, made possible by the "Pacific" wheel arrangement, that was the outstanding feature of Churchward's new locomotive. As originally built, this boiler (Fig. 3) had as much as 3400 square feet of heating surface and a wide firebox providing a grate area of 41·8 square feet. Though not the first to have a wide firebox, this boiler was certainly the largest to be used on a British railway at that time when the only other comparable in size was that designed and built by James Holden at the Stratford Works of the Great Eastern Railway for the experimental three-cylinder ten coupled engine of 1902, which had 3010 square feet of heating surface and a grate area of 42 square feet.

A characteristic of the boiler was that the large wide firebox was of the simplest construction without a combustion chamber and, therefore, in this respect similar to Ivatt's wide firebox "Atlantics" of 1902 for the Great Northern.

In the case of "The Great Bear," the omission of a combustion chamber necessitated the distance between the tube plates being as much as 22ft 7in. The photograph reproduced gives a very good idea of the size of this very large boiler as completed and ready for the erecting shop. The four cylinders had 8in piston valves and, except that they had a diameter of 15in instead of 14½in, were the same as for the "Star" class, and, as the steam pressure was the same as was the size of the driving wheels, the tractive effort was proportionately greater, being 27,800 lb as against 25,090 lb.*

In common with Swindon practice at that time, the engine spring suspension included compensating beams which, in the case of "The Great Bear," connected through from the leading pair of drivers to the radial axle at the trailing end. The use of this form of spring suspension is unusual in British practice, though was much favoured by Churchward, being a leading characteristic of his standard designs ; in the writer's opinion it contributed not a little to their easy riding. Many years ago we had on the Furness Railway a class of 4–4–0 passenger engines with compensated spring gear for the coupled axles which, aided by an Adams pattern four-wheeled leading bogie, thus

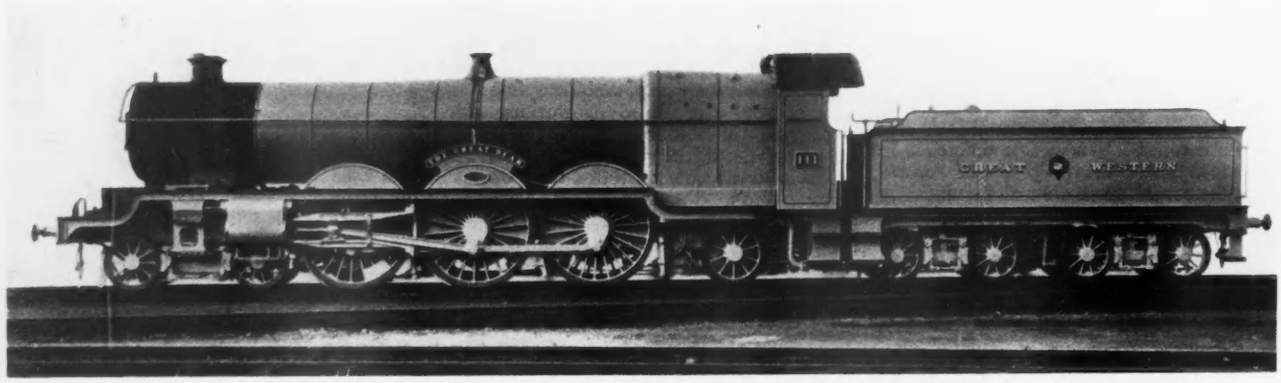
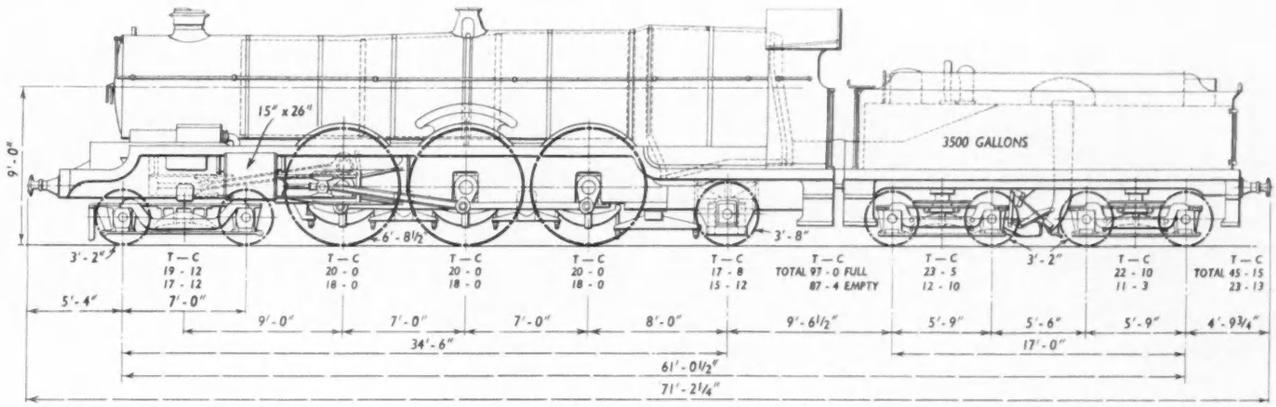


Fig. 1—Churchward's "Pacific" type locomotive, "The Great Bear"—G.W.R.

* The tractive effort of the four-cylinder engine No. 40, "North Star," and the engine "Dog Star" was inadvertently given as being 25,200 lb. This should have been 25,090 lb. See THE ENGINEER of November 23, 1906, and October 4, 1957.



Scale—¼in to 1ft

Cylinders	Four
Diameter, in	15
Stroke, in	26
Steam ports	25in × 1¼in
Exhaust	25in. × 3in.
Boiler :	
Barrel	23ft
Diameter, outside	5ft 6in and 6ft
Firebox :	
Outside	8ft × 5ft 9in/6ft. 6in.
Inside	7ft 2⅜in × 4ft 11⅛in/5ft. 8⅜in
Height	6ft 5 $\frac{9}{16}$in and 5ft 2 $\frac{9}{16}$in
Tubes :	
Superheater tubes :	
Number	84
Diameter	1in
Length	23ft 7⅛in
Fire tubes :	
Number	147 ... 14
Diameter	2¼in ... 5¼in
Length	22ft 7in ... 22ft 7in
Heating surface :	
Superheater tubes	398·52 square feet
Fire tubes	2596·97 square feet
Firebox	158·51 square feet
Total	3154·00 square feet
Area of firegrate	41·79 square feet
Wheels :	
Bogie	3ft 2in
Driving	6ft 8½in
Intermediate	6ft 8½in
Trailing	3ft 8in
Working pressure	225 lb
Tractive effort	27,800 lb
Total weight in working order :	
Engine and tender	142 tons 15 cwt.

Fig. 2—Weight diagram and main particulars of the locomotive " The Great Bear "—G.W.R.

giving three-point suspension, made them comfortable engines to ride on.

Returning again to " The Great Bear," a point regarding the leading bogie should be mentioned, because it differed from Churchward's former standard swing link pattern, though, like these, it had the bar type of framing; but the weight, instead of being taken on the engine centre line, was transferred to side bearers, an idea copied from the four-wheeled bogies fitted to the French-built compound engines then being tried in fast passenger traffic on the main line.

Regarding the firebox, originally four water tubes were fitted to support the brick arch, but were later removed. The large double-bogie, eight-wheeled tender was a further innovation. It had American type bar-framed bogies with compensated spring suspension. The diagram drawing of this remarkably interesting locomotive gives particulars of the wheel spacing and weight distribution, and other leading dimensions are given in tabular form.

THE ENGINEER of May 3, 1912, contained an article, together with an excellent set of general arrangement drawings. " The Great Bear " was probably before its time and, unfortunately, was really too heavy for the road ; in consequence, its sphere of action was strictly limited. However this may be, this remarkable engine marked a milestone in the development of British locomotives and, moreover, has proved to be the forerunner of others of the same type which, during more recent times, have put up excellent performances on British railways.

THE " FLOWER " CLASS

The four-coupled passenger engines of the " Flower " class (Fig. 4), specially built for services on sections of the line calling for light axle loadings, are mainly interesting as being a revival of a design originated by William Dean, Churchward's predecessor, as far back as 1900. Except that Churchward fitted his standard No. 2 boiler and modified the leading four-wheeled bogie, the new engines were, for all practical purposes, Dean's design.

The alterations made in the construction of the bogie arrangement are of interest. For all his engines of the classes requiring a four-wheeled leading bogie, Dean introduced one of an entirely novel form of construction to suit his standard design of cylinders which had the valve chests below and slide valves operated direct by Stephenson's valve gear. All Dean's engines had inside cylinders of this design so that on the introduction of a four-wheeled leading bogie about 1902, when the large 2-2-2 type " single " driver passenger engines of the " 3001 " class of 1891 were converted to the 4-4-2 type, it became necessary to provide a bogie which would permit of the ready removal of the valve chest covers to obtain access to the port faces.† The difficulty was overcome by introducing a modification of the Dean four-wheeled bogie in general use at the time for eight-wheeled coaching stock.

This bogie was of the suspension type and how it was adapted for 4-2-2 engines (and others fitted with cylinders of the pattern mentioned requiring a leading bogie) is nicely shown by the accompanying drawing (Fig. 5), kindly placed at the writer's disposal by his friend, Harold Holcroft.

As will be seen, this is actually a composite drawing showing on the left-hand side the Dean suspension arrangement and on the right how this was modified to comply with Churchward's requirements involving the fitting of outside bearers to support the load and to apply to the new " Flower " class—the only inside cylinder 4-4-0 type engines to have bogies other than the Dean suspension pattern. This drawing shows quite

† The conversion of the 2-2-2 type " single " driver locomotives Class " 3001 " to the 4-4-2 type was the result of the derailment of one of these engines in Box Tunnel, caused by a broken leading axle due, it was considered, to the axle load of 13·2 tons being excessive.

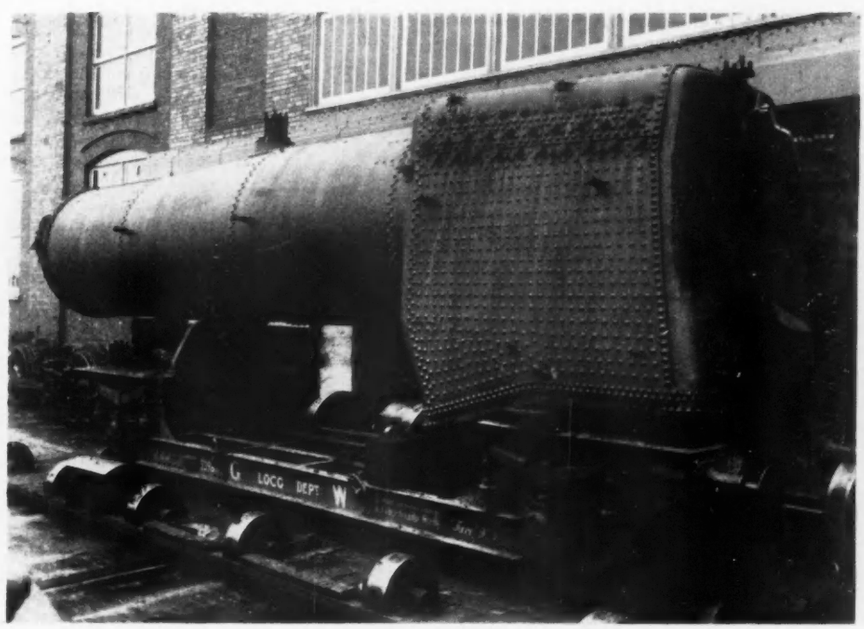


Fig. 3—Boiler for " The Great Bear "—G.W.R.

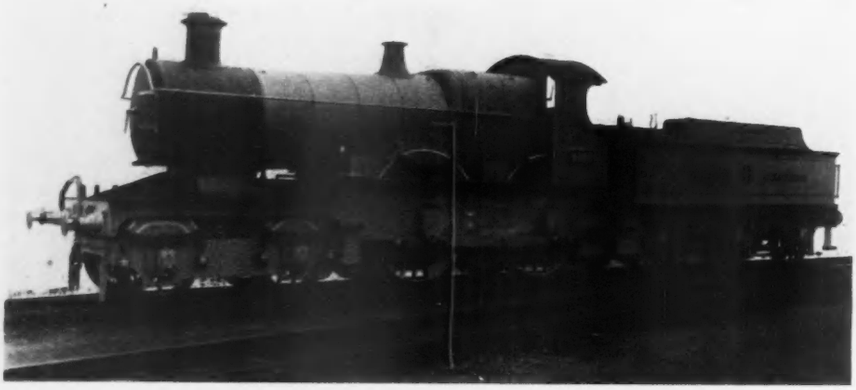


Fig. 4—Four-coupled passenger engine No. 4102, "Begonia"; "Flower" class—G.W.R.

clearly the Dean design which, it will be observed, consisted of two transverse members carried by four pillars, two on each side, attached to the engine main frames and suspended at their outer ends by four long bolts carried at their upper ends by brackets fixed to the outside frames of Dean's standard engine bogie. The two cross members were connected together at the centre of the engine by a box containing a central sliding block for the bogie centre pin, which entered the sliding block from the bottom and was carried by two frame stays fixed at each end to the bogie framing. The centre block holding the bogie pin was allowed a certain amount of lateral movement under the control of coil springs, as shown.

The Churchward bogie is shown on the right side of the composite drawing. It simply substitutes sliding blocks providing universal movement for the suspension system. This idea, copied as previously stated from the bogie design used for the French-built compound engines, became standard practice, superseding the American swing link type, previously the Swindon standard for Churchward's engines, which were all of the outside cylinder design.

The new Swindon four-wheeled bogie was confined to Great Western locomotives for some years, but was later introduced to a limited extent on other lines. In what particular way it was an improvement on the much more widely used types, such as the normal Adams and swing link arrangements, the writer does not know. In any event, the arrangement does not appear to have been entirely new, because, many years previous to the introduction of this side bearer idea on the Great Western, James Stirling on the old South Eastern used a somewhat similar kind of arrangement. This consisted of two brackets attached to the bogie frames, one on each side midway between the wheels; immediately above them, two further brackets were fixed to the engine main frames. These were formed like inverted cups and contained resilient material, probably of india-rubber, which rested on sliding pieces, bearing on the bogie frame brackets. The weight was taken, as usual, on the bogie centre, the purpose of these outer supports being, it would seem, to act as a steady for the front end of the engine. On the other hand, it may well have been that in some instances these outer bearers took some of the load; the writer is not, however, sure on this point. In any event, the existence of Stirling's bogie many years before the Swindon arrangement is certainly worth noting.

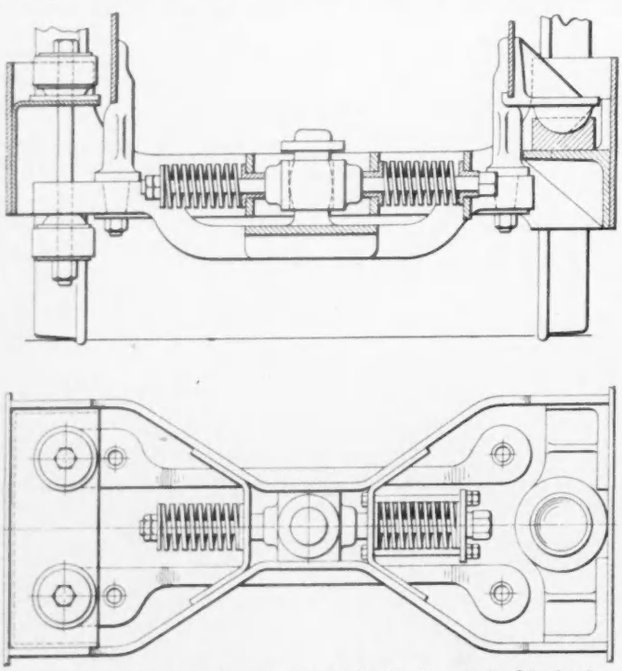


Fig. 5—G.W.R. four-wheeled bogies. Composite drawing. Left of bogie pin: Dean's suspension. Right: Churchward's outer bearing sliding design for "Flower" class

The leading dimensions of the "Flower" class, of which No. 4102, "Begonia," is illustrated, are as below.

G.W.R. 4–4–0 Passenger Locomotives

"Flower" Class

Cylinders:	
Diameter and stroke, in	18×26
Driving wheels, diameter, in	80½
Heating surfaces, square feet:	
Tubes	1369·58
Firebox	121·31
Total	1517·31
Grate area, square feet	20·35
Steam pressure, lb per square inch	195
Engine weight, tons:	
On drivers	35·7
Total	53·3
Engine and tender	93·3
Rated tractive force, lb	18,360

Swindon Superheaters

Particulars of the first applications made of flue tube superheaters were given in the two previous articles of this series reminiscent of past locomotive practice. In 1908 the Swindon No. 1 superheater of 1907 was fitted to the engine "The Great Bear," and a further new superheater came out. This was the Swindon No. 2, fitted to one of Churchward's 4–6–0 two-cylinder passenger locomotives No. 2922, "Saint Gabriel," and provided a superheater surface of 275 square feet. Like the former superheater applications previously mentioned, the superheater was fitted to a Swindon No. 1 boiler. While the Cole and the Swindon No. 1 superheaters fitted in 1907 were of the Field tube type, the Swindon No. 2 had elements of the now usual pattern, made up of 1¼in pipes fitted with return bends, two separate loops being fitted in each flue tube.

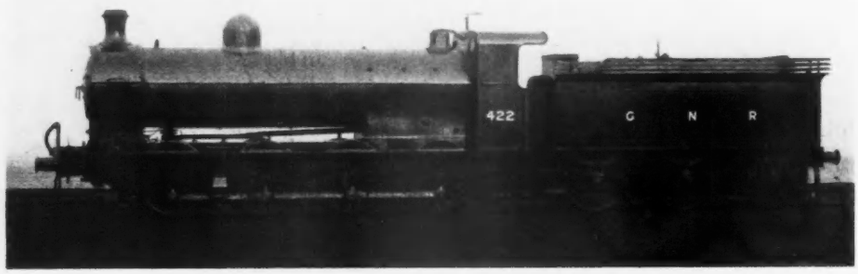


Fig. 6—H. A. Ivatt's 0–8–0 freight engine fitted with Schmidt superheater—G.N.R.

H. A. Ivatt's First Superheater Locomotive

The first experimental application of the superheater to locomotives on the Great Northern Railway was made when one of Ivatt's standard freight locomotives of the 0–8–0 type was fitted with the Schmidt flue tube superheater in 1908. This engine, No. 417, originally built at Doncaster in 1903, was equipped with a superheater of eighteen sets of elements, giving a superheater surface of 254 square feet, and at the same time the standard working steam pressure of 175 lb was reduced to 170 lb per square inch. The standard 20in by 26in cylinders with balanced slide valves were retained. One of these early superheater-fitted locomotives is shown by the photograph (Fig. 6) of No. 422, which is similar to the initial locomotive No. 417.

The leading dimensions of the first Doncaster superheater engine, No. 417, are tabulated at the top of the next page.

G.N.R. Freight Engines 0-8-0 Type Superheated

Cylinders :	
Diameter and stroke, in	20×26
Driving wheels, diameter, in	56
Heating surfaces, square feet :	
Tubes and flues	981·25
Firebox	135·50
Total evaporative	1116·75
Superheater	254
Combined	1370·75
Grate area, square feet	24·5
Steam pressure, lb per square inch	170
Engine weight, tons :	
On drivers	55·7
Total	55·7
Engine and tender	96·6

The Marsh Express Passenger Tank Engines

The 4–4–2 type side tank engines (Fig. 8), built at Brighton to the designs of D. E. Marsh for the Brighton line, were in many respects outstanding examples of the type and were, moreover, remarkably successful.

Marsh was one of the early exponents of high temperature superheating, and fitted one of his engines, No. 22, illustrated, with a Schmidt type superheater. Further noteworthy features include the use of coupled wheels having a diameter of 79½in, an unusual size for engines of this type, and large cylinders, 21in diameter with a piston stroke of 26in fitted with Schmidt pattern piston valves giving inside admission operated by Stephenson's valve gear through the medium of rocking levers, the valve chests being above the cylinders. So successful was this experiment that further engines of the same type were soon put in hand and in due course were employed to work a through passenger service between Brighton and the London and North Western Railway, operating these trains, then known as the "Sunny South Express," between Brighton and Willesden Junction.

Considering the question of water consumption, mention should be made of the fact that these engines were fitted with feed water heating apparatus whereby part of the exhaust steam was turned into the side tanks and two crosshead-driven pumps fitted to supply the boiler feed. Speaking in the discussion following the reading by Geo. Hughes of his paper, "Compounding and Superheating of Horwich Locomotives," before the Institution of Mechanical Engineers in 1910, D. E. Marsh gave some particulars of the performance of his engines, deduced from a series of trials carried out to determine the difference in water consumption of engines fitted with a feed water heater and when fitted with both a heater and superheater. The results are given in the accompanying tabulated statement (Table I).

Table I—*London, Brighton and South Coast Railway : Locomotive Trials*

D. E. Marsh, Institution of Mechanical Engineers, 1910.

Running conditions : 200 trailing tons, mean speeds 50 m.p.h.

Comparison of Water Consumptions.

(1) Locomotive without feed water heater or superheater, gallons per mile	36·12
(2) Locomotive with feed water heater only, gallons per mile	28·55
(3) Locomotive with feed water heater and superheater, gallons per mile	20·69

Comparison of Performance

Saving in water consumption :	
(2) compared with (1), per cent	21
(3) compared with (2), per cent	27·53
(3) compared with (1), per cent	42·7

It will be noted that fitting a feed water heater only gave an economy in water consumption of 21 per cent and that adding the superheater gave an economy in the water required per mile of as much as 42·7 per cent when compared with the locomotive not so fitted. Drawings of these superheated tank engines were published in The Engineer of April 1, 1910, which showed their distinctive features, including the arrangement of the feed pumps and, amongst others, the four-wheeled swing link leading bogie with independent spring gear made up of coil springs, one on each side of each axlebox, connected together by crossbeams spanning the axlebox under the box instead of over—the more common plan with this springing arrangement. Brakes were also applied to the bogie wheels, an unusual feature, though one distinctive of Churchward's practice.

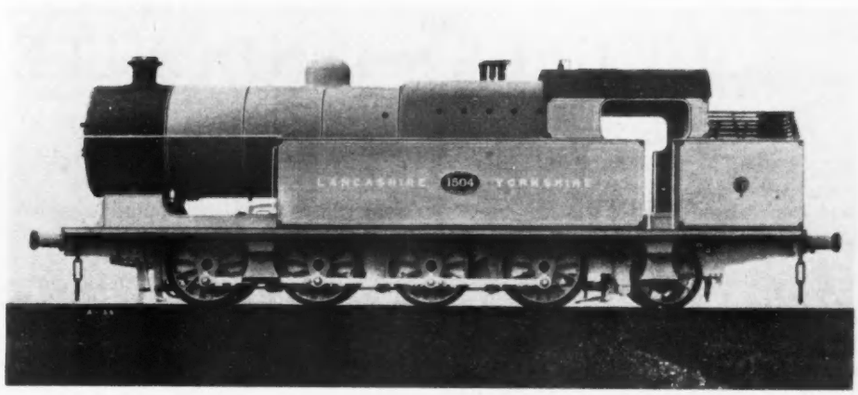


Fig. 7—0-8-2 type side tank engine for shunting and banking services. Geo. Hughes—L. and Y.R.

The leading dimensions of these engines are given as follows :

L.B. & S.C.R. 4-4-2 Tank Engines

Cylinders :	
Diameter and stroke, in	21×26
Driving wheels, diameter, in	79½
Heating surfaces, square feet :	
Tubes and flues	798
Firebox	120
Total evaporative	909
Superheater	293
Combined	1202
Grate area, square feet	24
Steam pressure, lb per square inch	160
Engine weight, tons :	
On drivers	38
Total engine	74
Rated tractive force, lb	19,250
Tank capacity, gallons	2,110
Bunker space, coal, tons	3

Lancashire and Yorkshire Locomotives

In proportion to the traffic handled and the mountainous nature of the terrain traversed, the late Lancashire and Yorkshire Railway was, if not the most difficult line in the country to work, certainly one of them.

Looking back fifty years to locomotive developments on this railway in 1908 will be found clearly to reflect the arduous duties expected of the motive power, exemplified by the introduction of an exceptionally powerful design of eight coupled side tank engines of the 0–8–2 type for banking purposes on some of the heavy grades common on this railway, and an entirely new locomotive for passenger services constituting not only an outstanding increase in potential power, but also distinctive as being an innovation when compared with former locomotive practice at Horwich, where Lancashire and Yorkshire locomotives were designed and built.

The very large eight coupled side tank locomotives designed by Geo. Hughes were specially intended for shunting or for assisting heavy freight trains on the steep grades found on many routes (Fig. 7). They were notable for two reasons : the large boiler of the Belpaire pattern and for the size of the cylinders with a diameter of 21½in, larger than had up to that time ever been used for a two-cylinder simple expansion engine with "inside" cylinders. With this large cylinder diameter and a piston stroke of 26in, combined with 54in coupled wheels and steam at 170 lb per square inch pressure, the rated tractive force amounted to 32,400 lb. In harmony with standard practice at Horwich, Joy's valve gear was used, operating slide valves in steam chests above the cylinders. The trailing pair of wheels had radial journal boxes and, further to assist in the safe negotiation of curves, the middle pair of coupled wheels had tyres without flanges and of increased width. The coupled wheelbase was 17ft 11½in and the total, 24ft 6in.

The leading dimensions of these engines are given as follows :

L and Y.R. 0-8-2 Side Tank Engines

Cylinders :	
Diameter and stroke, in	21½×26
Driving wheels, diameter, in	54
Heating surfaces, square feet :	
Tubes	2008
Firebox	190
Total	2198
Grate area, square feet	25·6
Steam pressure, lb per square inch	170
Weight, tons :	
On drivers	68
Total	84
Rated tractive force, lb	32,400
Tank capacity, gallons	2000
Bunker capacity, coal, tons	3

The weights given are approximate.

(To be continued)

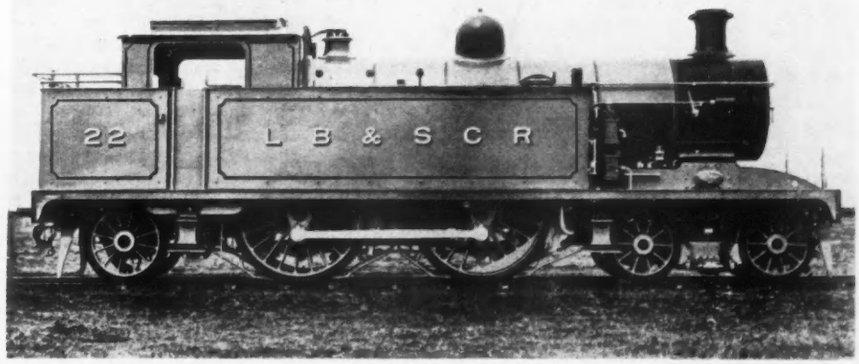


Fig. 8—4-4-2 type superheated tank engine for passenger services. D. E. Marsh—L. B. and S.C.R.

LETTERS AND LITERATURE

Letters to the Editor

We do not hold ourselves responsible for the opinions of our correspondents)

DIRTY HANDS

SIR,—It is a very great pleasure to find a commonsense attitude to modern car design which is all too rare nowadays, in your editorial of October 24. The two chief needs are for elementary ergonomic principles and for greater reliability, particularly of the more important accessories, such as batteries and cooling systems.

It is all the more surprising, therefore, to find in the very next section of the same editorial that your leader writer believes in what amounts to less shop floor, and more specialised practical training for young professional engineers. That would soon produce even more designers who place the least reliable components in the most inaccessible places and appear never to have attempted to carry out even elementary operations or repairs on the models they perpetrate. The two matters, Sir, are intimately connected. No amount of practical instruction in specialised apprentice schools is a substitute for having had to assemble a component (preferably with the assistance of outspoken manual workers !) which was obviously designed by a man who had never used a spanner ; or for following a welding sequence which would require four universal joints in one arm.

This whole subject was fully discussed by the Institution of Mechanical Engineers earlier this year, on the occasion of its sub-committee report. Few people spoke up in favour of an apprenticeship amounting to "sitting beside Nellie" ; but fewer still denied the importance of budding professional men spending a significant amount of time in study, not only of the work, but also the mentality of the men who will have to carry out their future instructions. As for your leader's suggestion that the apprentice should become a master of one trade rather than a dabbler in many, surely that misses the whole point in this kind of practical training ; it may be helpful to a production engineer or designer to be an expert turner, but, if he has acquired this skill at the expense of even a rudimentary knowledge of other basic techniques—well, Heaven help his employer : his men will help themselves !

But while there is no substitute for practical training on the actual shop floor, that is no reason for leaving the apprentice to his own devices and to the often somewhat inarticulate teaching of his "mate." Is it not possible to plan his departmental progress with care, co-ordinate it with his theoretical training and offer him the services of peripatetic full-time instructors who are able to enlighten him about the whys and the wherefores of his daily work and that of the department he finds himself in ?

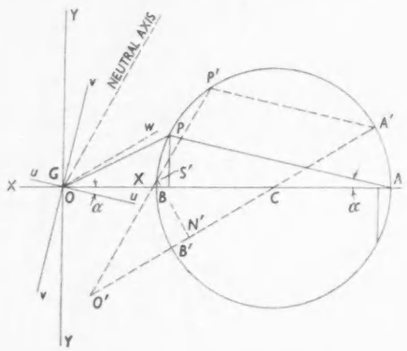
E. G. SEMLER

Editor,
Automation Progress,
November 7, 1958.

GRAPHICAL METHOD FOR OBLIQUE BENDING

SIR,—Referring to "Graphical Method for Oblique Bending" by T. F. W. Smith on page 129 of the issue of THE ENGINEER for July 25, 1958, an interesting extension can be obtained for the case where the moment is applied about an axis for which the second moment is unknown.

Thus, considering Fig. 1 of that article, and using the method in which the origin coincides with the centroid, if I_{xx}, I_{yy} and I_{xy} are known, the Mohr moment circle can



be drawn, and the principal axes obtained if not already known. Now suppose a moment M to be applied about an axis Ow, for which the three I quantities are unknown.

Then, draw CO' parallel to Ow, making $CO'=CO$, and cutting the circle in A' and B'.

Draw $A'P'$ parallel to Ou to cut the circle in P'. Then P' is the new pole, and the neutral axis is parallel to $O'P'$.

Also, $O'P'$ cuts the circle in S' ; hence, if a perpendicular $S'N'$ is dropped on to $O'A'$ then $O'N'=I_w$.

A. W. T. DANIEL,
M.A., Ph.D., A.M.I.C.E.

Queen Mary College,
London, E.1,
October 20, 1958.

Book Reviews

A History of Technology : Volumes I to IV. Edited by CHARLES SINGER, E. J. HOLMYARD, A. R. HALL and TREVOR I. WILLIAMS. Oxford University Press, Amen House, Warwick Square, London, E.C.4. Price 168s. per volume.

Now that the fourth volume of this remarkable work has appeared,* the time has certainly come for us to review the material so far published. For this volume covers the 100 years between 1750 and 1850, when the roots were put down of much engineering technology as we know it to-day, and when the art and science of engineering began to influence almost every other technology by mechanising the tools of the trades and bringing power to bear to do work which had formerly been done by human muscles. In the earlier volumes engineering plays a less prominent part in the story, although, if it can be upheld that the lineage of engineering can be traced back to the first makers of tools, engineering is at least as old as *homo sapiens*. The first volume covers the whole of technological history before 500 B.C., the second the next 2000 years, the third a further two and a half centuries bringing the story up to 1750, and this fourth volume reaches onward to 1850. This alteration of the time scale is significant. It is not solely because there is a lack of records that each earlier volume covers a much longer period than its successor, but because as the centuries have passed man's perceptions have quickened so that there is in reality more to record in each successive century. One wonders whether there may not, here, be evidence for some evolution in human powers.

In a certain way the volumes are disappointing. An engineer, for example, regarding them so narrowly that he took interest only in those parts concerned with engineering might not be satisfied. For very naturally the compilers have relied predominantly upon well-known sources for their material. An engineering reader, therefore, may find the majority of illustrations drawn from and discussions based upon works with which he is already familiar, such as those of Agricola and Ramelli in Volume III, and those of Dickens, Farey, Tredgold, &c., in the latest volume. The treatment, moreover, seems brief and much of interest is omitted. Disappointment, however, soon evaporates when other sections of the work are studied. For the value of this monumental work lies in the insight it gives to a reader into the history of technologies other than those with which he is specially familiar and into the relationships between various technologies. Furthermore, by no means all engineers who look at the present work will be familiar with engineering history. They will, we think, be filled with amazed admiration for the achievements of engineers in past ages, more particularly of the Romans. The volumes are all compilations—that is, in general, each chapter has been written by a different author, each author being an "authority" on his own subject. There is, of course, a weakness in such treatment. Each technology tends to get treated in isolation from the rest, whereas in fact there can be no doubt that advances in technological understanding in one field have reacted strongly upon other technological processes. But readers can demand too much ! No man lives to-day, who can comprehend simultaneously all technologies sufficiently well to review the whole historical development of technologies in the round and as a single expression of human purpose. The reader is here presented with expert knowledge and opinion in each separate field. When he wishes to trace fully reactions across technological boundaries then he must do some work for himself by intelligent study of the volumes.

We look forward with especial interest to the last volume in the series. For it is only in the last century that scientifically made discoveries have at all heavily influenced the development of technologies. It will be interesting to see what the authors, whom the editors will have collected together, will make of that period. In the meanwhile, it can be said that these are volumes that ought to find a place on the library shelves of every

* The fifth volume has just been published and will be the subject of a review very shortly.

engineer who can afford them. Alas! The qualification about expense has to be made. Such large, heavily illustrated and excellently printed volumes cannot be cheaply produced. Few individual engineers, we fear, will be able to buy them. But every technological firm which has a works library should make certain these volumes are available to its users. It goes without saying that all public libraries will obtain copies.

A Study of Several Aerothermoelastic Problems of Aircraft Structures in High Speed Flight. By JOHN C. HOUBOLT, D.Sc.Techn. No. 5: "Der Mitteilungen aus dem Institut für Flugzeugstatik und Leichtbau an der Eidgenössischen Technischen Hochschule in Zürich." Verlag Leeman A.G., Arbenzstrasse 20, Postfach, Zürich 34. Price Swiss francs 12.

THAT the "-thermo-" term in the title is entitled to inclusion is established even before reaching the "Contents," by a chart of stagnation temperatures on which such interesting points as "tungsten melts" and "graphite sublimes" correspond to a mere Mach 8 in the warmer parts of the stratosphere, 30 miles high. However, thermal loads, at least on airframes, never vary with the rapidity of aerodynamic and elastic forces, so that it is possible to determine the thermal conditions for a desired flight regime and then tackle the aero-elasticity problems for the reduced strengths and stiffnesses prevailing. Dr. Houbolt treats several cases more or less independently, but gives particular emphasis to panel flutter, and goes on to the behaviour of a panel in a flow field having random disturbances. This approach was, the introduction explains, made partly in order to allow several of the author's ideas to be included in one booklet. The text is English, and where it falls short of perfect the defect is usually obvious, as "principle" for "principal" and "referent" for "referee."

Business and Specialised Publications of Great Britain. Published by The Council of the Trade and Technical Press, Imperial House, Kingsway, London, W.C.2.

WE applaud the initiative of the Council of the Trade and Technical Press, a council of the Periodical Proprietors' Association, in publishing this booklet. For very few people outside the world of the trade and technical Press have even an inkling of the importance of the work it does; and even within that world few editors or even advertising managers really appreciate how very many such journals there are. This booklet lists over 150 weekly, monthly and quarterly journals and twenty-five yearbooks, annuals and biennials. A small photograph to show the outside appearance of each journal is reproduced and the brief particulars noted include the name and address of the publisher, the scope and coverage of the journal, the annual subscription, advertisement rates per page and the type area per page.

There is hardly a trade in this country that does not have at least one trade journal to bring to its practitioners news about markets and marketing methods, governmental activities, changing prices and quantities of other information essential to the carrying on of a business. And few professions lack technical journals which keep professional men in contact with the development of technological thought and equipment. It is literally true that the technological development and business dealings could not satisfactorily be carried on in a country so heavily industrialised as ours without the publication of trade and technical journals in all their immense variety; and some of those journals are especially adapted to meet the needs of exporting industries.

Now that this booklet has been published—it includes an Introduction by Sir David Eccles, President of the Board of Trade, and a brief article descriptive of the scope and function of the trade and technical Press—there is no longer any excuse for people to plead ignorance of the important part played in our national life by specialist trade and technical journals, most of which have negligible circulations by the standards of the national daily newspapers, but readerships (because they pass through so many hands) amounting to high proportions of all those engaged in particular professions or trades. Again and again since the war trade and technical delegations have come to this country and have been allowed to leave it without any adequate appreciation of the scope and excellence of its trade and technical publications. There was even a productivity team some years ago which went from this country to the U.S.A. without, to judge from its report, being at all conversant with the extent of the technical and trade Press of its own country! This new publication will help to prevent any such thing happening in the future.

Nuclear Reactor Experiments. By Staff of Argonne National Laboratory. Edited by J. Barton Hoag. D. Van Nostrand Company, Ltd., 358, Kensington High Street, London, W.14. Price 51s.

THE experiments described in this book are designed for instruction on the detection of nuclear radiation, the use of sub-critical assemblies, nuclear cross-sections, reactor characteristics, heat transfer to liquids, preparation of fuel, effects of corrosion and irradiation, and separating processes. The text and illustrations will undoubtedly be very useful to pupils at the Argonne School of Nuclear Science and Engineering, for it describes the experiments that can be performed there. To students elsewhere the value of the book will be rather less. One might hazard a guess that the work is based on laboratory notes that have been issued in mimeographed or similar form to Argonne pupils, and that the editor (who, as Associate Director, helped to launch the School in 1955) has been so close to his curricular work that he has not always been able to discern which parts of the notes are mainly of domestic interest.

While we do not object in principle to American linguistic usage, obviously and especially in the case of an American text, we feel bound to note that the language here is sprinkled with rather too many solecisms for clarity always to be attained. The book has 480 pages, of which twenty-five go to make up the very useful index, and twenty-three to appendices containing conversion factors, physical data and thermodynamic properties.

High Altitude and Satellite Rockets. Published jointly by the Royal Aeronautical Society and the British Interplanetary Society. Price 32s. 6d.

THE proceedings of the symposium held at the College of Aeronautics, Cranfield, on July 18 to 20 last year, are now available in book form, together with the discussions. They provide valuable and interesting reading on the subject, although the potential readership for individual papers varies enormously, such papers as those of K. J. Bossart, "Design Problems of Large Rockets," and W. F. Hilton, "Recovery After Re-entry by the Use of Aerodynamic Lift" (abstracted in our issues of July 19 and 26, 1957), having an obvious application and a widespread appeal, while that of N. C. Freeman, "Dynamics of a Dissociating Gas: Non-Equilibrium Theory," one of a series initiated by Professor M. J. Lighthill, could and did not give rise to discussion. Contributions to the discussions have been reproduced accompanied by illustrations, which has preserved such valuable information as the account by A. J. Cable of hypersonic facilities at A.R.D.E., Fort Halstead. Unfortunately, the retarded state of British developments in these fields is emphasised by the use of a photograph on the wrapper of a vehicle that has yet to fly.

Geological Structures and Maps. By A. ROBERTS, M.Sc. Cleaver-Hume Press, Ltd., 31, Wright's Lane, Kensington, London, W.8. Price 12s. 6d.

THIS is a second edition of a course in the interpretation of geological maps and geological structures; its scope has been extended considerably in the second edition. The general survey of the principles of interpretation of geological maps with graded exercises and the space to work them out, is now supplemented by chapters on some of the more important applications to civil engineering and to mine surveying and working. There is more on the various structures associated with coal seams, on the use of isopachytes, on various aspects of surface geology, on foundation problems in engineering, on water supply, oil-bearing structures, borehole sections and the location of concealed coalfields.

Mechanics of Machines: Elementary Theory and Examples. By J. HANNAH, B.Sc. (Eng.), A.M.I.Mech.E., and R. C. STEPHENS, M.Sc. (Eng.), A.M.I.Mech.E. Edward Arnold (Publishers), Ltd., 41, Maddox Street, London, W.1. Price 18s.

THE full title of this volume is an excellent indication of its contents. The standard aimed at is that of a first year degree student. The tutor can doubtless be relied upon to explain, for instance, that the term "vehicle dynamics" normally excludes the one-degree-of-freedom motion discussed under that title.

Books Received

Uplift in Gravity Dams. By Serge Leliavsky. Constable and Co., Ltd., 10, Orange Street, London, W.C.2. Price 45s.

Electricity in Aircraft. By F. G. Spreadbury. Constable and Co., Ltd., 10, Orange Street, London, W.C.2. Price 40s.

An Introduction to Fluid Dynamics. By G. Temple. Oxford University Press, Amen House, Warwick Square, London, E.C.4. Price 25s.

Engineering Systems Analysis. By R. L. Sutherland. Addison Wesley Publishing Company, Inc., Reading, Massachusetts, U.S.A. Price 60s.

Circuits a Relais et Automatismes a Sequences. By P. Naslin. Dunod Editeur, 92, Rue Bonaparte, Paris (6eme), France. Price Fr.2700

Tables Abregees de Puissances Entiieres. By P. Montagne. Dunod Editeur, 92, Rue Bonaparte, Paris (6eme), France. Price Fr.5600

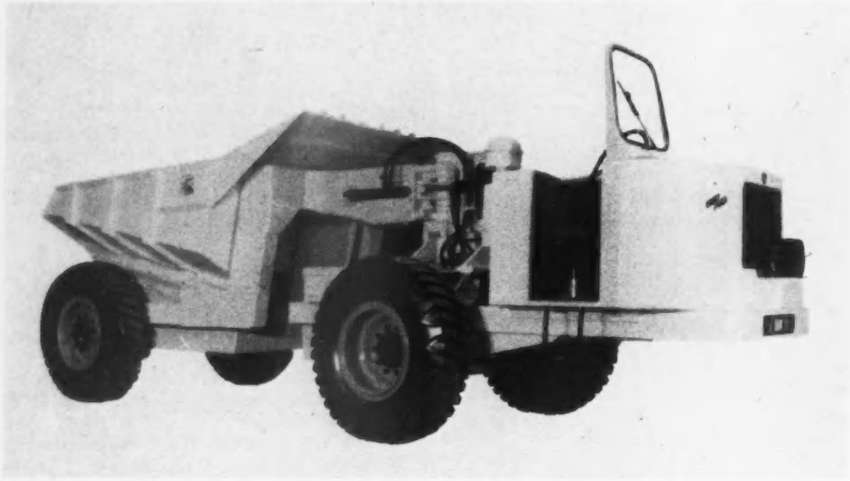
Newnes Engineer's Manual. Fifth edition. Edited by F. J. Camm. George Newnes, Ltd., Tower House, Southampton Street, London, W.C.2. Price 35s.

Nuclear Reactors for Power Generation. Edited by E. Openshaw Taylor. George Newnes, Ltd., Tower House, Southampton Street, London, W.C.2. Price 21s.

A Compendium of Mathematics and Physics. By D. S. Meyler and O. G. Sutton. The English Universities Press, Ltd., 102, Newgate Street, London, E.C.1. Price 25s.

Public Works Exhibition

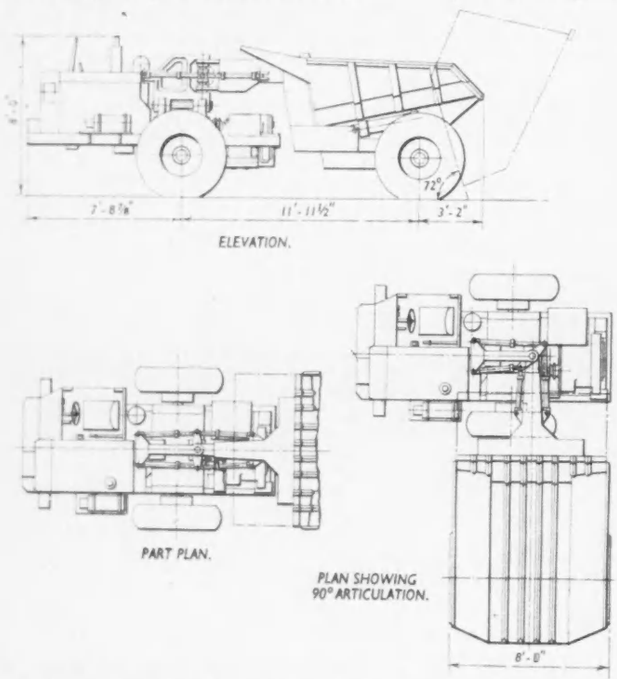
No II—(*Concluded from page 720, November 7*)



The Public Works and Municipal Services Congress and Exhibition has been in progress this week at Olympia in London. The exhibition itself will be open until 6.30 p.m. to-morrow. Here we conclude our review of the exhibition, with descriptions of some further machines of special interest, selected from amongst the very comprehensive display of plant to be seen at Olympia.

IF any of the various operations carried out by public works plant can be classed as fundamental to all the others, it is surely that of excavation and earth moving. The amount of plant adapted to this duty must form a large proportion of the total at Olympia, and its diversity is equally striking. Last week, our article started by describing a new form of dumper, and such is the scope of contemporary activity in this field that our second article can also most appropriately open by giving details of other developments in the design and construction of dumpers.

An original design has been evolved by Eimco (Great Britain), Ltd., involving an overhung engine, as shown in the illustration above. This machine—the firm's "model 850"—is of entirely British design and construction. It carries a pay load of 22,400 lb, equivalent to 9 cubic yards for general purpose duties, or 7 cubic yards where ore or rock are to be carried. The power unit is a Leyland AU600/35 diesel engine, giving 144 b.h.p. at 2000 r.p.m., and a maximum torque of 410 lb-ft at 1200 r.p.m. A five-speed gearbox gives a range of forward speeds of 3·4 to 30 m.p.h. (and one reverse speed), and the dumper, in common with other new designs to be seen at the exhibition, will climb a 1 in 4 gradient when fully loaded. Its width has been kept down to 8ft for "on the road" duty, and the gearbox arranged accordingly, with a high speed for "empty" journeys on the road.



Articulation and steering linkage of the "Eimco" dumper. The four jacks can give a 180 deg. swing on the pivot frame in six seconds. The whole frame can rock 15 deg. about the horizontal hinge on which it is mounted

The articulated linkage between the dumper body and the overhung engine is shown in the drawing, from which it may be seen that steering is controlled by hydraulic jacks acting about the pivot point. Note that there are four jacks, arranged in two opposed pairs, and that the whole steering assembly is carried on a horizontal axis, which allows a horizontal articulation of ±15 deg. between the two sections of the vehicle without affecting the steering. The two rear jacks are rigidly mounted on the swan neck, and the two front ones similarly on the linkage frame, and the outer ends of their rams are pin-jointed on the cross arm, as shown both in the drawing and heading illustrations. The jacks are double-acting and the pressure of the hydraulic system is 1000 lb per square inch. This arrangement of four jacks in opposed pairs has been adopted to give better steering characteristics—in conjunction with the hydraulic system used—than two. It may be noted that a swing of 180 deg. is obtainable in six seconds on the pivot frame, and this gives a turning radius of 10ft 6in. This particular system of steering, it has been found, may also be useful in dislodging a vehicle which has become bogged-down in mud, the steering jacks being operated to impart a "crabwise" movement.

Tipping is by hydraulic jacks, and the "jack-knife" movement possible on a machine of this kind (i.e. tipping by locking the back wheels and reversing) has been avoided, in the belief that a constant length of wheelbase is needed when the load is tipped, if accurate tipping is to be achieved. Other constructional features of the machine include a 16in diameter single-plate dry, heavy-duty, disc clutch, and transmission consisting of an independently mounted gearbox integral with a transfer box and driven by a propeller shaft from the engine. A secondary propeller shaft from the transfer box drives the axle. The chassis, dumper body and swan neck frame are of substantial welded steel construction and the dumper body has a wide mouth and a low tail lip.

20-Cubic-Yard Dumper

At least three firms in Great Britain now manufacture dumpers of very large capacity. One of them, Aveling-Barford, Ltd., is exhibiting its new "SN" 20-cubic-yard machine, which is illustrated, and which the firm claims to be the "most powerful" machine of its kind made in this country, stressing as a favourable point its power/weight ratio. The overall laden weight of this machine is about 100,000 lb, about half of which is useful load, and the power unit, as exhibited, is a Rolls-Royce eight-cylinder, turbo-charged diesel engine giving 400 b.h.p. at 2100 r.p.m., and with a maximum torque of 1130 lb-ft at 1400 r.p.m. Alternative engines for production machines will be a six-cylinder Rolls-Royce and a six-cylinder Cummins diesel engine, with either mechanical transmission or a torque converter. The clutch and brakes are air operated, and twin two-stage hydraulic rams can tip the body to 70 deg. in about twelve seconds. Six forward speeds, from 3 to 30 m.p.h., and a reverse speed of 4 m.p.h. are obtainable through a single lever, with the machine powered as exhibited, or four forward and two reverse speeds are possible with the alternative transmission.

The contractor's equipment of C. H. Johnson (Machinery), Ltd., Adswood, Stockport, includes three dumpers, one of which, the "One-20," is of new design. This dumper, with a payload of 20 cwt, is driven by a Lister diesel engine developing 6·3 h.p. at 2000 r.p.m. It has an articulated chassis designed to give a high degree of manœuvrability and stability on rough ground. The main chassis of fabricated rolled steel channels has a 3in diameter shaft at the front and this shaft forms a pivot for a front chassis. This sub-chassis carries the front axle, steering mechanism and the skip, with

its release mechanism. Drive to the rear wheels is transmitted through a dry plate clutch and a three-speed gearbox, giving a top speed of 10 m.p.h.

Another Johnson dumper, the " Twin 65," will be shown with a detachable skip which has a struck capacity of 18 cubic feet. These skips are intended for the transport of concrete to a crane and enable a number of skips to be used with a single dumper. Each skip is fitted with a bottom opening door. The larger machines on this firm's stand include a concrete spreader for road-making, which gives distribution over widths from 9ft 9in to 30ft, and a finisher which compacts depths of concrete up to 24in in widths from 10ft to 30ft.

Crawler Tractors

A new addition to the range of crawler tractors made by John Fowler and Co. (Leeds), Ltd., is the " Challenger 33," which is driven by a 125 b.h.p. Leyland engine and gives 105 b.h.p. at the drawbar. The machine has a deep-section, fully boxed, rigid, main frame, with heavy-duty cross members on to which the independent final drive units are flange mounted. Each of the tracks is supported from the track frames by five rollers and the frames pivot at the rear on a large cross shaft. A cranked front cross beam retains the tracks in parallel planes and is rubber insulated and spring damped to eliminate the effects of shock and vibration. This track provides a total area of ground contact of 3890 square inches, the complete machine weighing 28,000 lb.

The tractor has six forward speeds from 1·65 to 6·22 m.p.h., the respective drawbar pulls being from 24,500 lb to 5000 lb. Four reverse speeds from 2·28 to 5·64 m.p.h. are provided. The machine exhibited is fitted with a Marshall hydraulically operated angledozer and a cable control unit which has capacity to handle 10–14 cubic yard scrapers.

Two of the tractors made by Vickers-Armstrongs (Tractors), Ltd.—the " Vigor " and the " Vikon "—are exhibited by Jack Olding and Co., Ltd., of Hatfield. The " Vikon " is a new model which closely resembles the larger " Vigor " machine and is powered by a supercharged, four-cylinder Rolls-Royce diesel engine developing 143 b.h.p. It has a drawbar horsepower of 116 h.p., and its five forward and four reverse speed gearbox gives operating speeds of up to 8·85 m.p.h. The tractor has a weight of some 26,320 lb, which the tracks distribute over an area of some 3474 square inches. The makers' design of three-point, fully articulated suspension and reflexing tracks give maximum ground contact at all operating speeds. The machine is fitted with a hydraulic dozer, as shown in the illustration.

4-Cubic-Yard Scraper

As a final example from amongst the tractors and tractor-drawn plant at the exhibition, we illustrate the new 4-cubic-yard scraper introduced by David Brown Construction Equipment, Ltd. A point of interest about this scraper is that control of digging is given by double-acting rams, which apply a downward force to the lip, or cutting edge, of the scraper bowl. One of these rams can be seen in the illustration. Control of the scraper is, in fact, entirely hydraulic, with four $3\frac{7}{8}$in diameter, double-acting jacks, two controlling the bowl lift, one the tailgate and one the apron. The strokes of these jacks are respectively 1in to 8in, 1in to 11in and 2in to 5in, and the operating pressure of the hydraulic system is 950 lb per square inch. The cutting edge is 6ft wide, the depth of cut

Dumper of 20 cubic yard capacity

" Vikon " crawler tractor, 116 drawbar horsepower, fitted with a hydraulic angledozer

David Brown " 50TD," 50 h.p. crawler tractor with 4 cubic yard hydraulic scraper

9in, and the depth of spread 15in. The "struck" capacity of this scraper is actually 3·5 cubic yards, and the heaped capacity 5 cubic yards. The matching tractor is the "50TD" machine, of 50 b.h.p., and with a maximum drawbar pull of 12,000 lb.

Continuous Mixing of Asphalts

Another new piece of equipment shown on the stand of Jack Olding and Co., Ltd., is a Barber-Greene continuous mixing plant for bituminous materials. This plant is set up for producing bituminous mixes at a rate of up to 40 tons per hour. It comprises three individual units; a mixer, dryer and grading unit, all mounted on pneumatic tyred wheels for easy towing. Both the mixer and dryer are driven by individual diesel engines, whilst the grading unit, which is employed where the aggregate requires screening after drying, is driven from the mixer. The mixer may be used alone for the production of stabilised and wet mixes, when its capacity is up to 50 tons per hour.

When it is operating as a continuous mixing plant the aggregate is fed into the dryer, which incorporates a dust collector. The dried material is transferred by an elevator to the grading unit where it is accurately screened, each grade of material being delivered into one of three separate bins fitted with calibrated discharge gates. These bin gates can be adjusted so as to ensure the delivery of each grade of aggregate in the exact proportion required for the mix specification. The proportioned aggregate flows on to an apron feeder leading to the hot elevator of the mixer. As the aggregate is discharged into the twin-shaft pugmill on the mixer, it is sprayed with bitumen supplied by a positive displacement pump. Provision is made for varying the mixing time of the stream of material passing through the pugmill into a discharge hopper.

The feeder shaft drive on the grading unit is interlocked with the drive of the bitumen pump and, by altering the gear ratios of the two drives, the proportion of bitumen to aggregate can be varied to comply with the specification for any particular mix being produced. This "volumetric proportioning" is stated to be just as reliable as measuring by weight, and has the advantage that it can be carried out by controlling a continuous flow of material or liquid.

Compressed Air Plant

Products of all the companies in the Holman Group are exhibited on one stand. One piece of equipment new to the group is a rotary screw design portable air compressor, known as the "Holman Rotair" and made in capacities from 135 to 600 cubic feet per minute. This compressor made under an agreement with James Howden and Co., Ltd., consists essentially of two helical fluted intermeshing rotors mounted in one casing. As the rotors rotate air drawn through the inlet port to fill the interlobe space is trapped and compressed by a progressive reduction in volume until released into the discharge port of the compressor. The male rotor, which has four lobes, absorbs practically all the power required by the compressor, whilst the female rotor, which has six lobes, functions as a rotary valve.

In the portable compressor application high efficiency is achieved in a single stage by the use of oil cooling which results, without the aid of inter- and after-coolers, in air delivered at temperatures at least 100 deg. Fah. less than those obtained from conventional compressors. The increased rotational speeds of these compressors result in a high performance and they function at more than double the speed of a diesel engine, the use of step-up gearing giving a maximum compressor speed of 4000 r.p.m.

As the air flow through the compressor has axial flow characteristics only the delivery end of the machine is subjected to high pressure. The rotors are located by matched pairs of combined journal and thrust bearings at the delivery end and expansion is provided for at the opposite end by the use of standard roller bearings. Cooling and sealing is carried out by injecting lubricating oil into the compression chambers and detergent oil of a correct grade can be employed, as there are no vanes or other wearing parts to be considered. The rotors have positive clearances within the stator casing and the only friction is that between the engaging helices of the rotors. Since interlobe loading between the rotors is very light and a cooling fluid is used this rolling engagement results in only very small frictional losses.

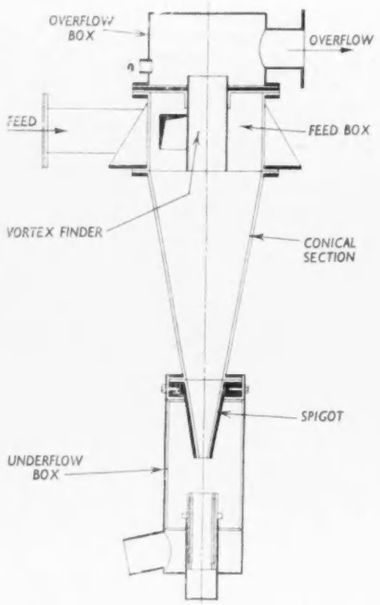
The output of compressed air is controlled automatically in the machines according to demand by a simple mechanism which slows the engine down until the compressor is ultimately off loaded. This is brought about by controlling the inlet volume at the intake of the compressor.

The Consolidated Pneumatic triple tamper

A new tool of interest to be seen amongst the air compressors, pneumatic tools and other equipment of the Consolidated Pneumatic Tool Company, Ltd., 232, Dawes Road, London, S.W.6, is a "triple tamper" illustrated above. This piece of equipment consists essentially of a rigid frame carrying three individual pneumatic tampers and controlled from a pair of handle bars. The machine is made in two models, one for heavy work being fitted with 2½in bore 6in stroke tampers with an operating frequency of 750 blows a minute. The lighter machine has 1⅞in bore 6in stroke tampers, and it weighs 118 lb as compared with the 185 lb of the other machine.

Dewatering Sand

The preparation of sand for concrete presents much more difficulty than is entailed with the coarse aggregates, and consequently there is a variety of special equipment for specialised purposes such as measuring the water content or effecting hydraulic classification of the sand. An example of equipment in this general category, but in this case serving to separate sand from the water with which it is washed, is exhibited by Wilkinson Rubber Linatex, Ltd., of Camberley, Surrey. The complete set of equipment comprises a sump, which regulates the feed of the slurry of sand and water, a centrifugal pump, and a centrifugal separator mounted on a tower, with chutes for discharging the sand into stock piles.

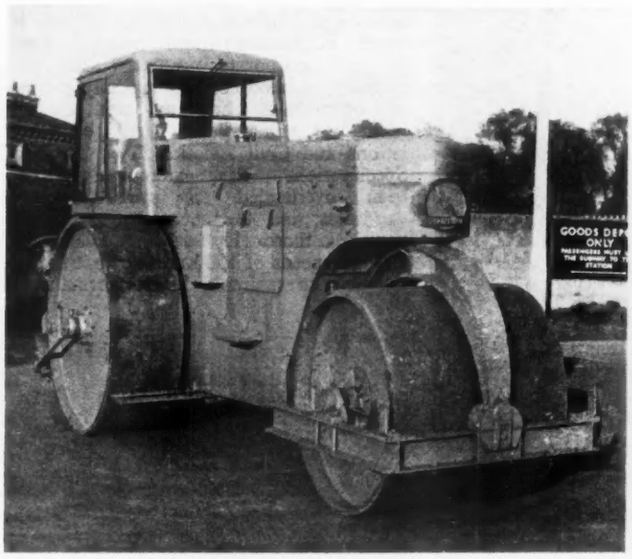


Cross-sectional illustration of the "Linatex" device for separating sand and water

The regulating sump consists of a vessel shaped as an inverted cone, its top edge forming a weir. Excess water flows over the weir to waste, and the sump also serves to keep a constant suction head on the centrifugal pump, and give a more even concentration of sand in the slurry pumped. The slurry is delivered to the separator under a head of 10ft to 20ft, the exact head depending on the size of the separator, the grading of the sand, and the result specified.

The separator is illustrated diagrammatically herewith. The slurry enters the "feed box" tangentially, and under the influence of the hydrostatic head at the entry pipe, and the conical shape of the vessel, flows round the feed box in a vortex, so that the sand tends to be thrown outwards. At the centre of the vortex is a tube, called the "Vortex Finder" which is open-ended. The diameter and depth of this tube are to some extent critical in the process, and the upward velocity of water in the tube is kept below the settling velocity of the smallest sand particles which it is desired to retain. Thus the device is, in effect, a classifier; generally particles which will pass a 200 mesh are allowed to escape up the tube to the overflow.

A second control of the separating operation is achieved at the spigot and underflow box. Dried sand flows, as a "rope," out of the spigot end, and the average concentration of sand in the slurry is matched by the size of the hole in the spigot end. This can be adjusted by fitting shorter or longer spigot end pieces as needed. Should the sand concentration suddenly fall, the dried sand in the conical vessel will gradually be expelled, and water will also pass down through the spigot end. This water will, however, issue through the spigot hole as a spray, called an "umbrella" discharge, and will thus fall



Road roller fitted with hydraulic transmission and controlled by a single lever

The Matbro "Mastiff" loading shove

in the underflow box, where it will be returned to the sump, and the dried sand in the central tube will not be affected. The proportion of water in the sand separated out by this device can be kept down to about 20 per cent by weight, it is claimed, which is little more than fills the voids in the sand.

Rollers

During the period of the exhibition, Marshall Sons and Co., Ltd., of Gainsborough, is demonstrating in London a "Road-Marshall" road roller, equipped with hydraulic transmission. This machine has been developed in conjunction with Dowty Hydraulic Units, Ltd., and provides single lever control both for reversing and throughout the speed range. The control lever can be moved directly from full forward to full reverse, and the change of direction is stated to take place without snatch or shock.

This transmission system consists basically of a variable delivery tilting head piston pump, driving a fixed displacement motor, the pump being driven by the prime mover, while the motor drives through a reduction gear to the rear rolls. Variation of the pump angle controls the speed and direction of rotation of the hydraulic motor, and consequently of the roller. The lever controlling direction of movement and speed actuates a servo control. At zero pump angle the lever is in the neutral position. Forward or reverse movement respectively is produced by moving the control lever to either side of the neutral position, and the speed of movement, in either direction, is proportional to the distance the lever is moved. The system functions as a smoothly and infinitely variable transmission ratio and provides a "stepless" performance.

The system operates in reverse when the roller is over-running the engine, so that the normal frictional brake is not required. The rolls are locked when the operating lever is in the neutral position.

Generally, the trend in rollers shown at the exhibition seems to be towards increased use of vibratory compaction, and a number of vibrating rollers are exhibited. One of them is a machine introduced by Thomas Green and Son, Ltd., and is a hand-guided power-propelled machine of 8 cwt. Another example is the "Vibrocon" 28 cwt vibrating roller made by Winget, Ltd.

Loading Shovel

A large loading shovel known as the "Mastiff" demonstrated on the stand of Mathew Brothers, Sandy Lane Works, North Wallington, Surrey, is illustrated on this page. It is designed for a maximum working load of 4000 lb and is available with a range of buckets from $\frac{3}{8}$ to 3 cubic yard capacity. The machine is driven by a Ford 96 h.p. engine through a 3 to 1 ratio torque converter followed by a two forward and one reverse speed power shift transmission, and a two-speed transfer gearbox feeding two double-reduction non-steering axles through a constant velocity universal joint. This arrangement gives road speeds of up to 17 m.p.h. with a practical working drawbar pull of 12,000 lb.

The machine is carried on four pneumatic tyres and is of articulated construction which is effected by two hydraulic cams and the control of a conventional steering wheel. This arrangement gives the machine a turning radius of 150in or 166in over the bucket; there is 20in of axle articulation. The bucket arms are actuated by large double-acting hydraulic rams which give a maximum outreach of 6ft 4in. The bucket can be tipped at 63½ deg. at a height of 9ft and an outreach of 2ft 5in; with the same outreach and a bucket tipping angle of 30 deg. the lift height is 10ft. The bucket breakout force is 17,000 lb and a bucket crowd or roll back of 40 deg. is provided.

Paver-Finishers

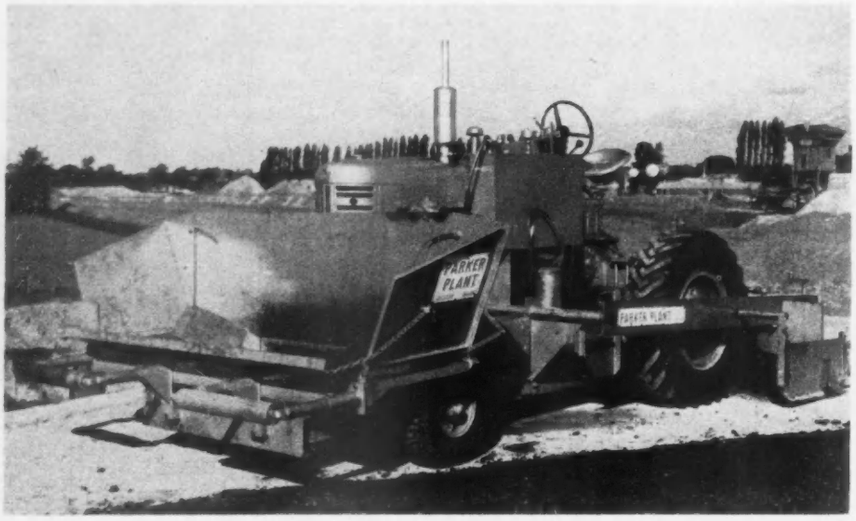
Three newly introduced paver-finisher machines are to be seen at Olympia. The British-built PF 45 machine, made by Blaw-Knox, Ltd., is a pneumatically tyred machine similar in many respects to the larger PF 90, which was described in these columns on January 27, 1956. The PF 45 lays a width of material of 7ft to 11ft up to 8in thick, at working speeds varying from 4ft 6in to 62ft per minute.

Another pneumatically tyred paving machine which is now in production at Leicester at the works of Frederick Parker and Co., Ltd., is illustrated overleaf. The machine is assembled on a standard British tractor. It can turn on an inside radius of 5ft, and has hydraulic steering and paving speeds from 3ft to 60ft a minute. It moves under its own power at travelling speeds up to 16 to 17 m.p.h. and has five forward gears and one reverse.

Control of the machine's laying speed and most other functions is hydraulic. Its screed is heated by bottled gas, and there is stated to be precise "crowning" adjustment. Laying capacity is up to 80 tons an hour, and the minimum paving depth is ½in. The material from the hopper is taken to the rear of the paver by transfer conveyor. An oscillating cutter-compactor bar finally lays and compacts the material and the "floating" screed at the rear of this completes the operation.

Our final example of paver-finishers is a Barber-Greene machine, the model 873, exhibited by Jack Olding and Co., Ltd., which is exhibited for the first time outside the U.S.A. We are informed that the machine retains the automatic-tamping-levelling principle pioneered by Barber-Greene over twenty years ago, but it combines the benefits of crawler track and pneumatic tyres in one machine. The wheels are for towing, and lie within the 8ft overall width of the main chassis. They are retracted, by hydraulic rams, and the machine actually operates on crawler tracks.

The steering control is a single joystick, instead of independent clutch control levers. For working, the sides of the hopper may be opened out from 8ft to 10ft. As the feeders carry the material back to the screed, the operator can raise the hopper sides by hydraulic control, discharging all the material with little or no hand shovelling. To control the flow of material from the hopper to the spreader screws, a single, hydraulically controlled deflector blade is mounted above and toward the rear end of the hopper feeder. Movement of this deflector to either side diverts extra material to whichever side requires it for bleeding-out or laying a super-elevation. The screed unit has a hydraulic hoist. The profile control follows the pattern of the larger Barber-Greene finisher. The screed is heated by bottled gas. The standard laying width is 8ft, variable between 6ft and 12ft in 3in increments, using cut-off shoes or extensions. The thickness of the mat is variable from ¼in upwards. Four laying speeds are provided, from 7·7ft to 49ft per minute.



The Parker paver, shown working on secondary roads crossing the London-Yorkshire motorway

LORRY MOUNTED EXCAVATOR

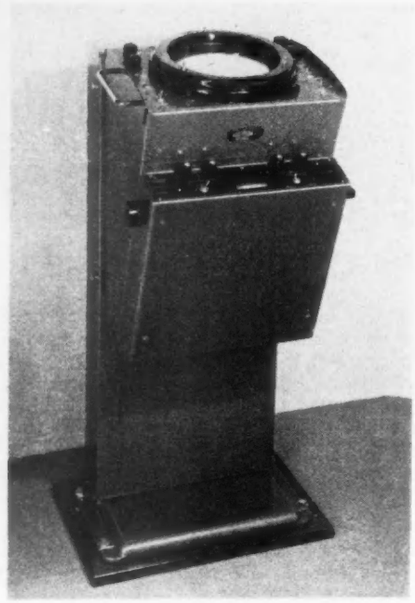
A contractor's machine adaptable for a variety of work, shown by Ruston-Bucyrus, Ltd., Lincoln, is a lorry-mounted "22-RB" crane/excavator. As an excavator this machine has a capacity of $\frac{3}{4}$ cubic yard and it is fully convertible to a shovel, a drag-shovel, a dragline or a grabbing crane. As a crane it has a capacity of 22 tons and is shown equipped with a 70ft boom and a 20ft offset jib. The maximum boom length is 80ft with a 30ft jib, and the booms used are of pin-connected, self-erecting, design. The power unit of the machine itself is a Ruston diesel engine developing 66 h.p. at 1275 r.p.m. The six-wheeled Foden chassis is distinguished by having extreme roll stiffness on each rear axle individually.

Marine Radar Series

Since the first radar set was put into service Decca Radar, Ltd., has introduced, at intervals, new sets of improved performance and able to satisfy the requirements of a greater number of individual classes of ship. A recent development has been the design of a completely new range of radar consisting of seven sets adequate to satisfy the navigational demands of widely diversified classes of tonnage.

DURING the years since Decca Radar, Ltd., installed its first set on board ship approximately 7800 sets have been put into service, which represents nearly 40 per cent of the ships fitted with radar, so that the company has attained international status in this particular field. From time to time, as a result of research and development, new sets having improved performance have been marketed culminating with the introduction some two years ago of True Motion radar "TM 46," of which a description appeared in our issue of November 16, 1956. Even at this date thought was being given to the sets of the future, with particular attention being paid to the replacement market which would inevitably make its appearance with the passage of time. Hitherto progress had been made by improving the design of existing sets or the introduction of sets to serve particular classes of ship. But the next forward move planned was based on a different concept, namely, the marketing of a completely new range of radar. This new series has been designed to cover adequately the requirements of the widely diversified classes of tonnage which make up the merchant marine of the world, and it is considered by the company that the sets will be able to fulfil the specific needs of each individual class of ship. A study of radar at sea and consultations with users finally decided that the series should consist of seven sets, which would include two True Motion radars, thus enabling the shipowner to select a set giving the required standard of performance at an economic price for his particular ship and trade. No longer is it necessary to select a radar set on the basis of a compromise. The "D7" series, as the new range is named, is claimed to provide standards of performance and reliability which are an improvement upon existing sets. Furthermore, the development of a range of radar sets has meant that there are a greater number of common parts thus making for easier maintenance and reduced costs. All sets incorporate printed circuits and carefully planned controls logically grouped for operational simplicity, and conform with the Ministry of Transport regulations and Civil Aviation Type Approval Specifications. The external design has been overhauled to provide greater sturdiness, and the scanners of new design have been thoroughly tested in a wind tunnel at wind speeds of 100 knots so that the sets are able to maintain full performance in winds of hurricane force. Fins have been added to the scanner to reduce the torque effect of wind.

Pedestal display unit with self-contained true motion



Pedestal mounted 9in diameter display unit

The "D7" series are arranged in three groups; in Group 1 are three radars of low cost, light weight and high performance designed for ships in which both the space and the power available are limited. Group 2 includes two high quality units suitable for first class tonnage; one replaces the Decca 45 and the other, which is a True Motion unit, replaces the Decca "TM 46." Two radars of the highest quality and of exceptional performance form Group 3; they are of high power and one is a True Motion model. The accompanying table gives the principal particulars of the series.

Mark	Display	Aerial	Power	Range, nautical mil.s
Group 1:				
Decca 303	9in	4ft	10kW	36
Decca 404	9in	6ft	20kW	48
Decca 505	9in	6ft	75kW	48
Group 2:				
Decca 606	12in	6ft	20kW	48
Decca TM 707... ...	12in	6ft	20kW	48
Group 3:				
Decca 808	12in	6ft	75kW	48
Decca TM 909... ...	12in	6ft	75kW	48

Based upon the experience gained with the Decca "TM46," True Motion radar has been further developed to incorporate automatic alignment of the radar picture and true motion input, tidal correction controls, automatic resetting indicator and zero speed switch for assessment of relative motion. The Decca "TM909" is designed for ships requiring radar of the highest standard and offers five alternative radar presentations

Scanner with 6ft aperture and side fins

instantly available with automatic azimuth alignment, namely : relative motion, ship's head up ; relative motion, north up (azimuth stabilised) ; off-centred relative motion ; true motion, log speed input, and true motion, manual speed input. Our illustration shows the pedestal display unit in which the controls have a logical layout, with those for true motion grouped on the upper panel. One of the new controls introduced is the electronic range marker switch for altering the scale of the range marker to provide accurate reading at long (6 to 48 nautical miles), medium (1·5 to 12 nautical miles) and short range (0·75 to 1·5 nautical miles). There are seven range scales available, namely, $\frac{3}{4}$, $1\frac{1}{2}$, 3, 6, 12, 24 and 48 nautical miles, and true motion facilities apply to ranges between $1\frac{1}{2}$ and 12 miles.

The radar transmitter, receiver and main monitoring and testing facilities are contained in the 75kW bulkhead mounted transceiver which can be installed up to 60ft of wave guide run from the aerial. Pulse lengths of 0·1 and 0·5 microsecond are employed and the recurrence frequency is 1000 pulses per second. Rain and snow suppression circuits are included and are brought into operation by an " Anti-Clutter Rain " switch so that " wanted " targets are clearly seen, and in addition there is an " Anti-Clutter Sea " control which enhances the effect. The transceiver has been designed for wide band operation so that there is practically no drift in tuning. The receiver has an i.f. of 30 Mc/s and a bandwith of 10 Mc/s minimum and a video band width of 7·5 Mc/s, the overall gain being 130 dB. Our illustration shows the tilted cylinder parabolic aerial, which has a 6ft aperture and is driven at 20 r.p.m. by a $\frac{1}{3}$ h.p. motor; it is partly aerodynamically balanced and has a horizontal beam of 1·2 deg. and a vertical beam of 23 deg. at half power points, with the side lobes being better than 26 dB within and better than 32 dB outside ±10 deg. of the main beam. Range discrimination is better than 30 yards and the range marker is accurate within 1 per cent of the range ring calibration, while the range rings are accurate within $1\frac{1}{2}$ per cent. Bearing discrimination is 1·2 deg. and the accuracy is within 1 deg. in response near the edge of the tube and of a higher order when the electronic bearing marker is in use.

Bearing transmission is by self-aligning magslip with servo loop, while the power unit is a motor alternator with voltage regulator, having an output of 230V, 1000 c/s, and a consumption of 2·2kW. The display consists of a 12in diameter P.P.I. tube with long afterglow, bearing scale, bearing cursor and variable range marker.

We illustrate also, on a pedestal mounting, the display unit used with the three Group I radar sets. This 9in diameter fixed focus P.P.I. is also designed for deckhead or bulkhead as dictated by requirements of space and is a self-contained unit operating from a basic radar supply. The Decca 404 set which is equipped with this display unit has a 6ft aperture aerial and a 20kW transceiver: the particulars of the pulse characteristics and receiver are as for the " TM909." The range display is calibrated with seven range scales, as follows : $\frac{3}{4}$, $1\frac{1}{2}$, 3, 6, 10, 25 and 48 nautical miles, the discrimination being better than 30 yards and accuracy within $1\frac{1}{2}$ deg. of range scale in use, or 75 yards, whichever is greater. Bearing discrimination is 1·2 deg. and accuracy is within ±1 deg. on responses near edge of tube measurement is by a direct drive bearing cursor. The motor alternator has a consumption of 1kW and an output of 230V, 1000 c/s. The foregoing general descriptions of two of the seven sets forming the new series, namely, the Decca " TM909 " and Decca 404, serve to indicate broadly the equipment and performance of the range.

A long series of tests have been carried out, using a set installed on board the coaster " Standsted," in areas where there are poor radar response targets. Comparison with a Decca 45 has indicated that the new units have a better performance. A Decca 404 is already at sea on board the trawler " Kelvin," and it is anticipated that the first ship to be equipped with a Decca " TM909 " will be the " Kamperdyk," building at Lübeck for the Holland America Line.

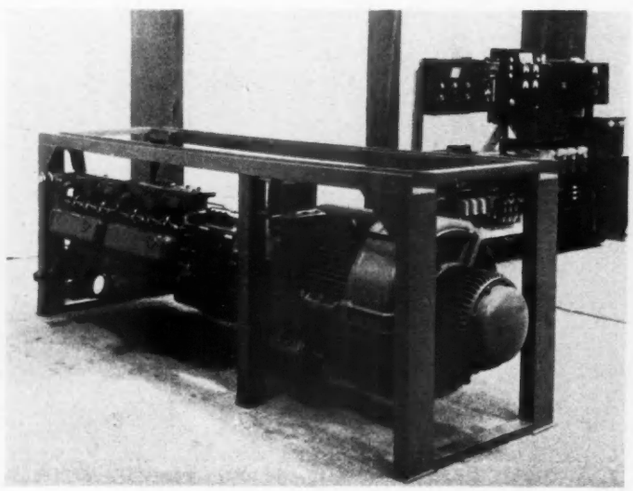
Railway Equipment Exhibition

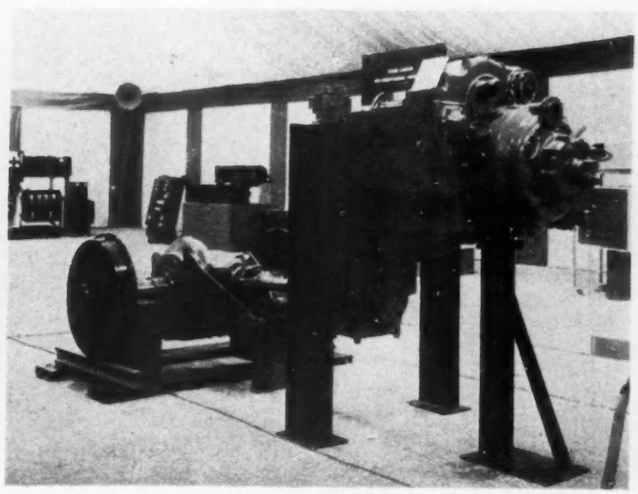
AN exhibition specially arranged to show members of the Institution of Locomotive Engineers products of the Stone group of companies was held recently at the works of J. Stone and Co. (Charlton), Ltd. In the main the exhibits were concerned with equipment for diesel and electric locomotives.

One of the central exhibits was a panel showing the large amount of auxiliary equipment the company is supplying for the diesel multiple-unit main line trains being built for British Railways by the Metropolitan-Cammell Carriage and Wagon Company, Ltd. Each of these eight-coach trains will have two of the underframe-mounted auxiliary power sets one of which we illustrate on a demonstration frame on this page. These sets will supply power for lighting, heating and cooling, air-conditioning, water heating, refrigeration and battery charging. Under winter conditions the total maximum load for an eight-car train will be 160kW, and under summer conditions, when cooling is required, 120kW. Each set comprises a Rolls-Royce eight-cylinder horizontal diesel engine (rated at 190 h.p., 1500 r.p.m.), coupled to a Stone's three-phase four-wire, 400V, 50 c/s a.c. alternator, continuously rated at 120kW at 1500 r.p.m. The alternator, which is totally enclosed and externally fan-cooled, is automatically controlled by a carbon pile regulator with transformer stabiliser.

Each of the power sets is permanently arranged to feed one distribution feeder system situated down one side of its train, and except under extreme winter conditions the other set will serve as a standby. The circuits are so designed that either set may be started up to take priority loads and the second set to come in and provide for the remaining load.

Some time ago the company acquired a licence for the manufacture of the " Mekydro " hydraulic power transmission system and a typical locomotive set can be seen in our second illustration. This design of transmission incorporates a permanently filled torque converter which operates in conjunction with an automatic, four-speed, gear changing mechanism. It is made in three standard sizes covering traction horse-





Auxiliary diesel engine alternator set for underframe mounting, and (right) hydraulic power transmission unit for locomotives

powers from 400 to 1800, and each form can be supplied to meet different arrangements of output cardan shafts.

The " Faiveley " design pantograph for electric railway traction made by the firm is a further development of the equipment adopted for high-speed duties by the French railways. It is designed to operate at speeds up to 100 m.p.h. in either direction of running and to comply with the requirements of running on lightweight catenaries. The base of this equipment is a welded steel assembly and the articulated members are principally of alloy steel tubing. The operating air motor is arranged in such a manner that, once the pantograph has been raised, the motor is completely disconnected from the moving system. The air motor is connected through a throttle valve giving a suitable speed of rise and fall and, should the air supply fail, the pantograph is automatically withdrawn from the line and rendered safe. The collector is arranged to collect currents up to 900A on light-weight single catenaries at voltage of 6·25kV or 25kV. To comply with the present requirements of British Railways, the equipment exhibited was adjusted to give 20 lb static pressure plus an increase at 100 m.p.h. of 2 lb.

Amongst the air-conditioning equipment for passenger coaches exhibited was a pressure ventilating equipment designed for British Railways. This equipment is built in unit form and can be operated with steam heating or high voltage electric heating units or with provision for both. One of the firm's " Stone-Vapor " steam generators shown in operation was typical of the four models now being made for train heating purposes and having capacities for up to 1000 lb, 1750 lb, 2750 lb, and 4500 lb of steam per hour at 70 lb to 275 lb per square inch. Another " Stone-Vapor " product is the " Watch-man " heater which is primarily designed to maintain coolant water temperatures in diesel engines, and thereby avoid adverse operating conditions in warming-up periods. It also has applications in large domestic hot water and central heating systems. It is an oil-fired hot water heater and circulator of 125,000 B.Th.U. per hour capacity, with fully automatic heater operation. A single electric motor drives the forced draught fan, fuel and circulating water pumps, and runs continuously with the burner cycling on and off under thermostatic control.

The "Faiveley" and the "Kheops" designs of intercoach couplers are now made by Stones. The first of these couplers provides for the safe transmission of high tension currents from a loco-motive to all coaches in a train. They are suit-able for supplies up to 3000V d.c. or 1500V a.c., 16⅔ or 50 c/s and a maximum current of 400A. Key operation of these couplers ensures that the apparatus must be made safe before the key can be removed, and the key then serves to close the isolator at the locomotive end of the train. The " Kheops " couplers are suitable for the transmission of power at medium tension between coaches and are for supplies at 600V a.c. and a maximum current of 300A.

Oilfield Trailers

TWO unusual designs of trailer have recently been supplied by R. A. Dyson and Co., Ltd., to Messrs. Shell Petroleum. We reproduce two views of a bogie for Compania Shell de Venezuela used in moving completely assembled drilling masts, which may be 133ft long and about 38 tons in weight. The bogie supports the mast some way in from the crown block end in order to reduce bending moments and the difficulty of manœuvring. The trailer carries a frame, inclined to match the taper of the mast, and four lever-action clamps operated by independent hand-wheels secure the mast in place. The frame is located on the chassis with no constraint in rotation by a ball-ended king pin. Rolling of the frame is limited to 5 deg. each way by stops, and inside these stops there are coil springs which keep the frame level laterally for loading.

Because the bogie has four (twin) wheels not in line, the pitch attitude also has to be controlled. The wheels are mounted on walking beams, so that stiffness in pitch (of the bogie) is negligible when the train is assembled. To render loading and unloading simple, however, the frame is, as mentioned above, allowed to pitch on the chassis, and during loading it is located in this direction as well as roll by coil springs. When the mast is in place, two ball-ended jacks con-centric with the springs are tightened to prevent any subsequent movement : the ball ends define a fore-and-aft line through the king pin ball end because of the rolling motion. All these fittings are mounted on a subframe which can rotate on rubbing circles on the chassis. The subframe can be locked by spring-loaded pegs, either to the chassis, for normal towing, or for manœuvr-ing to a ring surrounding the sub-frame which can be steered manually by a Reynolds chain.

The chassis is provided with steady legs to support it when unloaded, a telescopic drawbar for towing it unloaded and also for shunting it into position under a mast in the horizontal attitude, and a screw-operated hand brake. It can support up to 20 tons.

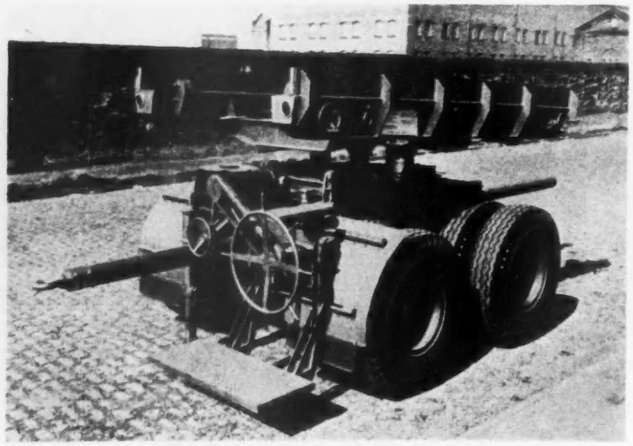
For the Shell-B.P. Petroleum Development Company of Nigeria, Ltd., to transport heavy equipment over swamp land in the Niger delta, a 28-ton trailer has been built with Cuthbertson rubber and steel tracks. (These tracks were described in our account of the " Water Buffalo " on July 13, 1956, page 50.) At the rear of the trailer there are four wheels for each track, the load on them being equalised by balance beams, and at the front there are three mounted on a walking beam.

A tracked trailer with a ground pressure less than 9 lb per square inch for use in the Niger Delta

The main frame of the trailer is a box, water-proofed to add buoyancy, the bottom being a skid plate. The platform, 9ft 3in wide, is supported by outriggers. A roller runs the full width of the tail for loading purposes.

The forecarriage is similarly boxed and there-fore forms the drawbar : there is a universal fifth wheel. A tractor with a 2in S.A.E. king pin can replace the forecarriage. To allow coupling and uncoupling when on soft surfaces, the support leg has an " elephant's foot."

The trailer will have an all-up weight of 44 tons with a ground pressure of only 8lb to 9·lb per square inch. Braking is provided by the tractor only.



A bogie to support a drilling mast in transit. The left-hand view shows the chassis, which has walking beam suspension, supported by a steady leg : the sunlight falls on the king pin. On the right, one of the roll stops and its spring can be seen : the steering gear is of the classical wormwheel and chain design

SHORTER REPORTS

New Technological Award

IN order to encourage qualified men and women to undertake further study beyond the level of the Diploma of Technology and to carry out original investigations, the National Council for Technological Awards has decided to create an award higher than the Dip. Tech. The intention is that this award shall be a mark of outstanding distinction granted to a student who has proved his ability by completing a substantial programme of work demanding the application of his knowledge to the solution of a problem of value to industry. It is proposed to establish a "College of Technologists" and the new award is to take the form of Membership of this College: its short title will thus be M.C.T.

To qualify for the new award a student must undertake a programme of work to be carried out jointly in industry and at a technical college; the programme may be concerned with any technological aspect of industrial activity, such as research, development, design, production or market investigation. The Council believes that to carry out successfully post-diploma work of this character, students must remain in contact with industry or with commercial laboratories. Before starting on such a programme a student must apply to the College of Technologists, through the technical college at which he will study, to be registered as a candidate. The College will consider particularly the qualifications and experience of the student, the suitability of the programme offered and the arrangements to be made for carrying out the work, both at the technical college and in industry. The programme offered should be related to the student's personal experience in industry and must have the approval of his employer. Its nature must be such that it is likely to result in a useful contribution to technological knowledge and that, like the Dip. Tech., it requires industrial experience and academic study extending over a substantial period. The Council suggests that a three-year period of work would cover the requirements, provided it can be arranged for a high proportion of a student's time to be devoted to the programme of work proposed.

Registration of candidates for the new award will not be restricted to holders of a Diploma in Technology, but may be extended to holders of equivalent qualifications. Teachers in technical colleges will be encouraged to become candidates for the award. The student's work must be supervised by a staff member of the technical college at which it is undertaken and by a staff member of the industrial organisation concerned. The technical college concerned will be responsible for the examination of candidates seeking membership of the College of Technologists, subject to any general arrangements, including the approval of external examiners, which may be prescribed by the College of Technologists.

Faraday House Engineering College

THREE interesting innovations at Faraday House Engineering College were explained at a press conference last week by Colonel B. H. Leeson, chairman of the board of governors of the College, and Mr. G. H. Randolph Martin, principal of the College.

The first of these changes relates to the award of Diploma Faraday House: when the academic part of this course has been successfully completed there will be an intermediate award of "Graduate Faraday House," G.F.H., which will be followed, on completion of the practical training, by the award of the Diploma Faraday House, D.F.H. This award is intended to cover the broadest field of electrical engineering by similarly broad concepts and study of fundamentals.

The second innovation is designed to achieve a somewhat different educational objective by covering fundamentals, with more concentrated study in a particular zone of the whole field of electrical engineering. To this end a new award of "Associate Faraday House" is being introduced next year. It will be given for studies in one of the following "zones" of electrical engineering, namely, power engineering, light engineering, telecommunications, electronics. The zonal system is not specialist training, nor does it aim to produce specialists. The training given will be broad within the limits of the zone chosen and within those limits the student may expect to gain a deeper knowledge than would be expected from the broader D.F.H. training.

The third innovation is the reintroduction of an industry-based sandwich course with a sequence of six months' academic work and six months' practical training. This sandwich course will be an alternative to the usual system of a number of academic years (normally three or four, depending on the entry level), followed by a period of practical training, and it will apply equally to Diploma and Associate students.

Very briefly the system is intended to work as follows in the case of industrially based students. An industrial concern will choose a number of men having potential ability to benefit from the tuition. Their educational qualifications will determine the entry level into the College, and, therefore, the length of the course. After a year or two years, depending on the entry level, a choice will have to be made between the two objectives—Diploma or Associate. In the case of the industrially based students the choice will be a tripartite one, involving the employer, the student and the principal of the College. A similar choice will be available to the private, as distinct from the industrially based, student.

As a background to these changes it may be recalled that Faraday House Engineering College, in association with the Electrical Standardising, Testing and Training Institution, Ltd., was established in 1889 with a view to meeting two great needs for the then young electrical industry. These needs were the setting up of a College where sound and systematic training could be afforded for men who desired to enter the industry, and the provision of suitable testing facilities so that the high standard of equipment then envisaged could be maintained. The standardising section of the College ceased to exist when the facilities were no longer needed, having been taken over on a national basis. The College, however, continued and did for a large number of years provide a sandwich system of education, the development and pioneering of which was its sole idea and responsibility. This system consisted of an educational programme which allowed a student to have alternative periods of training in the College and in industrial organisations.

For reasons of academic expediency this system was discontinued about six years ago and the training then instituted in the College consisted of three consecutive academic years, followed by one year's practical training in an industrial organisation. Thus the general idea of combining theoretical and practical training was maintained.

Earlier this year the Board of Governors was increased numerically, and the Board now consists of Colonel B. H. Leeson (chairman), F. A. Bell (deputy chairman), Sir Josiah Eccles, Sir Vincent de Ferranti, Messrs. T. E. Goldup, S. E. Goodall, J. O. Ince, J. F. R. Ince, Sir Frederick James, Sir Hamish MacLaren, Dr. A. D. Merriman, Sir Gordon Radley, and Mr. L. W. Smith.

Practical Training for Electrical Engineers

A CONFERENCE on the practical training of electrical engineers has been organised by the Institution of Electrical Engineers and is to be held in London next Friday, November 21. The council of the I.E.E. has for some time been concerned that the plans to expand the industrial training of professional engineers have not kept pace with the Government's programme of expansion for the universities and technical colleges to increase the number of technologists. It has been said that, if the technical colleges continue to expand at the present rate, they will succeed in providing their share of the extra 10,000 technologists per year which it is estimated will be needed by 1970. This would be, in the words of the Advisory Council on Scientific Policy, "a remarkable educational achievement." In the past, the burden of the complementary industrial training has fallen almost entirely upon the large manufacturing firms and the operating organisations, which have now reached the limit of their training capacity.

If a substantial increase is to be obtained in the number of engineers who receive adequate industrial training in electrical engineering, then means must be found to provide such training facilities in the smaller, and particularly in the more specialised, firms in the electrical engineering industry and in those concerned in the utilisation of electrical power. Many of these concerns cannot provide the breadth of training which is necessary within their own organisation and the conference is being held to encourage discussion of the possibilities of co-operative effort in the provision of such training. Further details of the conference may be obtained from the Secretary, The Institution of Electrical Engineers, Savoy Place, London, W.C.2.

Electricity Bulk Supply Tariff for 1959–60

LAST week the Central Electricity Generating Board announced its tariff for bulk supplies to be sold to the Area Boards in the year beginning April, 1959. The new tariff will yield substantially the same revenue as if the present tariff were continued, but its make-up shows significant changes, continuing the past trend of the tariff. The present form of the tariff (a fixed charge per kilowatt of maximum demand and a running charge per unit subject to fuel cost adjustment) is retained, but the new scale of charges relates the demand charge more nearly to the Generating Board's fixed costs and the running charge to running costs. The fuel adjustment charge is reduced to take account of the high efficiency of the modern stations which carry a large part of the load.

The new bulk supply tariff for 1959–60 is made up of a maximum demand charge of £7 2s. per kilowatt (compared with the present £6) and a running charge of 0·41d. per unit (compared with 0·46d.). In addition, the coal cost adjustment of the running charge has been reduced to 0·00055d. (compared with 0·0006d.) for each penny by which the fuel cost per ton in the year shall be above or below 60s. The tariff retains the modification to the fuel cost adjustment clause introduced in 1957–58, which enables importing Area Boards in relatively high fuel cost areas to benefit from imports of energy generated in relatively low fuel cost areas and transmitted in bulk over the Supergrid. Subject to any unforeseen economic changes, the Board hopes to avoid major alterations to this new bulk tariff for the next three years; it is hoped that it will encourage improvements in load factor.

London Colney By-Pass

THE Home Secretary, Mr. R. A. Butler, opened the London Colney by-pass on the trunk road, A.6, in Hertfordshire, last Friday. This 2½ mile length of road, built at a cost of £400,000, will take traffic away from the congested high street of London Colney and relieve pressure on the River Colne bridge, which was built by Thomas Telford when he was reconstructing the London-Holyhead Road to carry the Irish Mail coaches early in the nineteenth century.

The new road has two 24ft carriageways, designed to take up to 15,000 vehicles a day, but

can be widened to take three traffic lanes in each direction in the future. At each end of the by-pass there is a large oval roundabout. The one at the northern end connects with the North Orbital road and the road leading to St. Albans, and the one at the southern end links the new road to A.6 and the Hatfield-Radlett road B.556. The southern roundabout is designed so that later it can be converted into a fly-over junction. There are no side road junctions.

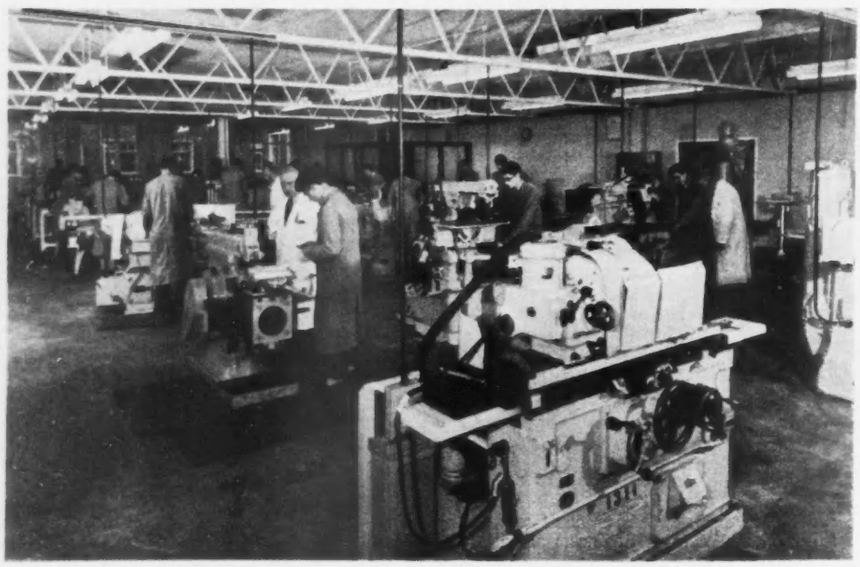
Three new bridges have been constructed in reinforced concrete. One carrying Whitehorse Lane over the by-pass has four spans ; the other two take the road over the River Colne and Lobbell Lane. Construction of the by-pass included the excavation of some 200,000 cubic yards of earth, most of which was completed during a fine spell of weather in the spring, and the laying of some 14 acres of asphalt. The carriageways consisted of 6in of stabilised soil, topped with 12in of dry lean concrete, a gravel asphalt base and a granite asphalt wearing course. The contract period for the construction work was fifteen months but, in spite of floods during the winter and an exceptionally wet summer, the contractor has reduced this period by two months. The whole of the work was designed and supervised for the Ministry of Transport and Civil Aviation by the County Surveyor of Hertfordshire, Lieut.-Colonel C. H. ffolliott, B.A., M.I.C.E., and the work has been carried out by John Laing and Son, Ltd.

Hollerith Engineering Training School

A NEW engineering training school which has been opened by the British Tabulating Machine Company, Ltd., at Letchworth, Herts, is organised for the two-fold purpose of training field service engineers and the initial training of apprentices for the firm's factories in the area. This school, covering an area of some 24,000 square feet, is a well-equipped two-storey building which includes fourteen class-rooms and a large workshop. The main class-rooms in which field engineers are trained by specialists in the maintenance, installation and applications of Hollerith machines, are equipped with a representative range of the company's products to the value of some £36,000. On entering the field engineering section of the organisation, each man undergoes a twelve-months' basic training, of which thirty-two weeks are spent in the school, before he goes out in the field. To keep the men in this section of the firm's organisation up to date with its developments, a series of refresher courses on new equipment are continually in progress.

All engineering apprentices, on being engaged by the firm, are first sent to a one-week industrial appreciation course which is run by the county educational authority. They then spend eighteen months in the school, during which time they are given a comprehensive grounding in the machine and fitting shop shown in the accompanying illustration. During this period basic exercises in machining and fitting are supplemented in most cases by the making of "one-off" parts for special pieces of equipment and mechanisms, such as may be required for demonstration purposes. In this way the interest of the apprentices is ensured by the knowledge that the parts made are of practical value, whilst there is imparted an appreciation of the necessity for skill and precision in manufacture. At the conclusion of training in the school, the apprentices move to the main factories of the firm in the Letchworth area, where they spend six months in each department. The final two years of each youth's apprenticeship are spent in the trade section of a works in which he will eventually be employed. Throughout the training period the apprentices attend the local technical college, and after they have left the initial training school their progress is checked each week in an interview with an executive from the school.

In addition to craft apprentices, the school is responsible for the initial training of the post-graduate trainees, student apprentices and computer technician apprentices, included in the overall training scheme of the British Tabulating Machine Company, Ltd. The scheme of training includes an opportunity for selected craft apprentices to become student apprentices in their fourth year, and those selected have a further opportunity to follow a "sandwich" course in mechanical or electrical engineering.



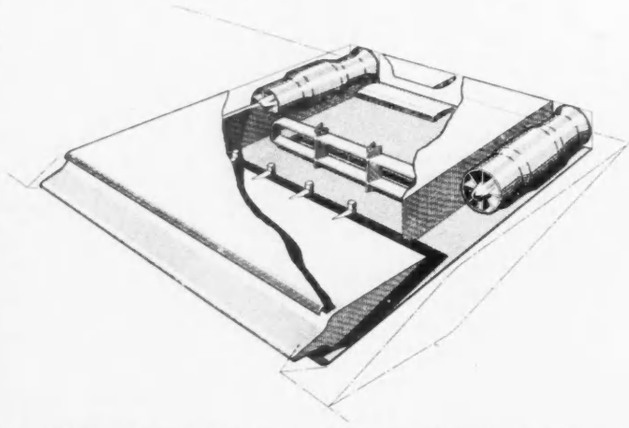
Machine shop end of apprentices craft training department with fitting section in the background

Integrated Airframes

THE 1956–57 Report of the Aeronautical Research Laboratories mentioned that attempts were being made to design a model of a "thrusting wing," i.e. a wing in which ram-jet engines are completely enclosed and whose aerodynamic characteristics at supersonic speeds should be considerably improved by such an installation.

The Summer, 1958, issue of the "Bristol" Quarterly includes some details of British proposals in this direction. It is pointed out that, except for missiles and a few military roles, the ram-jet aircraft must have turbo-jet engines for take-off.

In a "turbo-ram-jet" aircraft, the turbine requires a high mass flow at low speed, when the ram-jet takes little, and at high speeds the ram-jet needs a large and the turbine a relatively small one. Thus, a single intake to serve both needs a reduced range of adjustment of swallowing capacity.



Power plant combining turbo-jet and ram-jet elements within the wing thickness ; the supersonic intake will serve both, thus reducing design problems

By integrating a variable-geometry intake and a "letter-box" nozzle with the wing, as in the illustration, the power unit drag becomes very low, while the structure is that of a very thick wing.

It will be recalled that a Bristol turbo-jet, the Wright "J.67," was used in the Republic "F.103," but in that aircraft the air flow was divided between the engines by a movable mechanical partition.

Icebreaker Design and Building

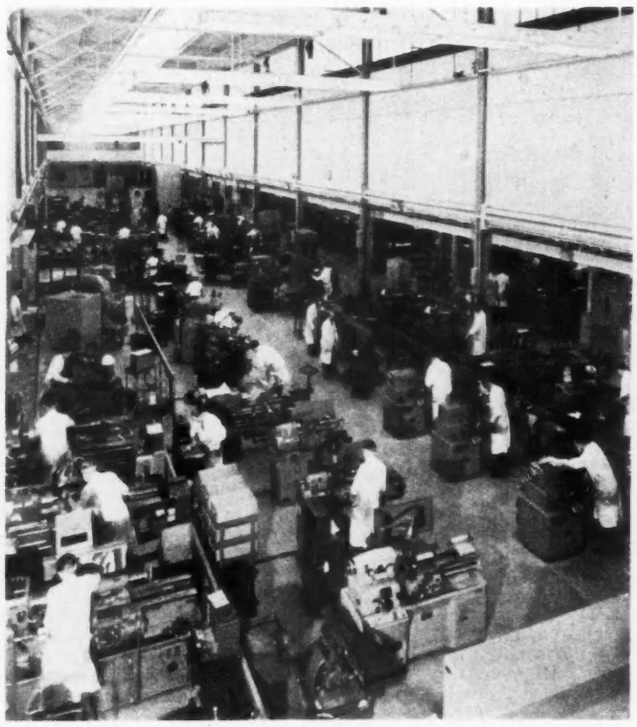
ON Tuesday, November 11, a paper by Mr. A. Watson, entitled "The Design and Building of Icebreakers," was presented to the Institute of Marine Engineers. The paper deals with experiences of the Canadian Department of Transport in operating a fleet of icebreakers over a period of twenty-five years, and is mostly concerned with the practical application to icebreaker design of information obtained from the operation of icebreakers under Canadian conditions. The Canadian Arctic consists mainly of islands and inlets which stretch over an area of 2000 miles north and south, and a little more east and west. A large part of the area is eternally icebound and cannot be reached by ships, but the largest part is accessible to icebreakers in season.

The advent of flying has made it possible for Canada to establish development and control centres in the Arctic, but flying must be complemented by the use of icebreakers. There is only one established port (Churchill) and elsewhere in the north there are few ports of refuge, no wharves, and no permanent cargo handling facilities. The geographical set-up shows tremendous ice pressure concentrations due to the shape of the land and the effect of wind and ice in the large areas of open water. The ice presents greater difficulty than the ice farther south, because new ice very often forms a matrix for heavy old Arctic ice, which is heavy enough, and is liable, to do serious damage to underwater plating of ships. It is therefore essential that the icebreaker should carry lifting equipment heavy enough to land all material which has to be put ashore, and also landing craft to get materials from ship to shore. The ships also require to be fitted with helicopters.

Engineering Department of Valve Factory

THE large-scale production of radio valves, television tubes and transistors involves a considerable amount of machinery of very specialised design. For this reason, the Mullard Radio Valve Company, Ltd., itself designs, develops and manufactures almost all the production machinery which it uses. At Mitcham Works, the southern production headquarters of the company, the engineering department has recently been reorganised and housed under one roof. At the same time the drawing office has been completely re-equipped. We recently had an opportunity of visiting this part of the works which is concerned with the design and manufacture of new plant for the production of valves, transistors and other semi-conductor devices, television and instrument tubes, X-ray tubes, and magnetic ferrites ; the adaptation of existing machinery to new processes; plant overhaul and maintenance ; and the training of apprentice engineers for work in the department. Excluding the apprentices, the department employs nearly 300 people. Our illustration shows a view of the machine shop. Among the developments we noted a device enabling the tail to be welded to a valve cathode after the remainder of the electrode cage has been assembled, a procedure which will considerably simplify the assembling process, and an extrusion machine for the automatic manufacture of indium pellets of constant weight. Other recent developments include an automatic valve-filament inserting device ; some mechanically-assisted aids to valve assembly ; an electronically-controlled cathode spraying plant ; automatic error correcting devices used, for example, for cutting wires to specified lengths with extreme accuracy ; and a number of automatic, variable-pitch frame-grid winders. A frame-grid is a component of some of the latest radio valves, and to make it, wire only 10 microns thick has to be wound on a frame in such a way that the turns are closer together towards the ends than in the centre. The automatic winder does this at high speed, winding 145 accurately spaced turns on a frame only 7·5mm long.

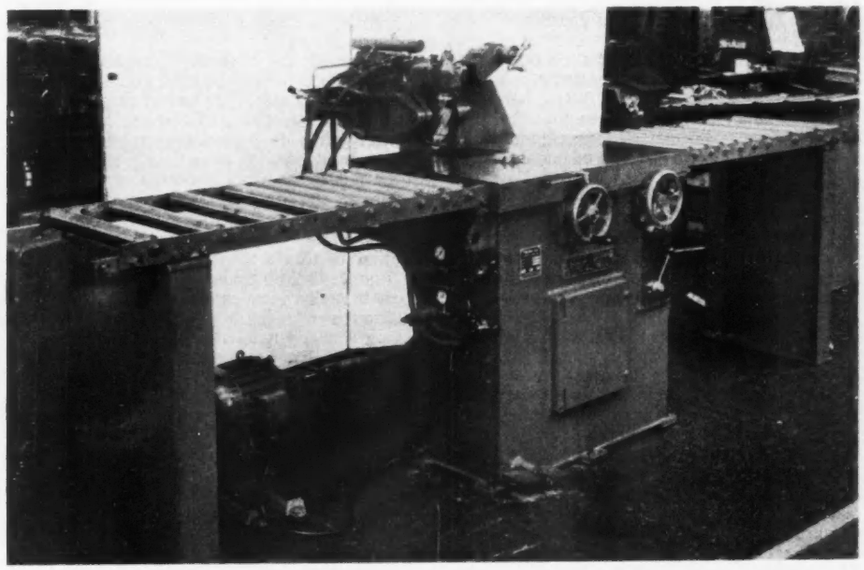
In the new drawing office, particular attention has been paid to working conditions and layout. Drawing boards are mounted on "Nike" hydraulic stands and can be raised, lowered, tilted or swivelled by foot operation. Filing of drawings is either horizontal or vertical. For the guidance of designers, a number of showcases houses an up-to-date display of standard components and special materials which are commercially available.



Valve engineering department, showing the turning section, capstans and milling machines for small-batch production, with the machine building section in the background

Variable Angle Spindle Moulder

WE illustrate below a variable angle spindle moulder which Wadkin, Ltd., Leicester, recently supplied to a British aircraft manufacturer.



Variable angle spindle moulder for aircraft components having a variable angle on a profiled edge

This machine is particularly applicable to making aircraft components, having a variable angle on a profiled edge, that are of a size which can be conveniently housed in a jig to be moved past a vertical cutter spindle.

The machine, as can be seen, is based on a standard spindle moulder having a main frame carrying a horizontal machine table. Above the table is a vertical cutter spindle driven by a 5 h.p. motor through a flexible shaft at 3000 r.p.m. The cutter head is carried on a compound, horizontal-vertical slide on which the cutter head has a horizontal or transverse movement of 9in and a vertical movement of 6in. In addition, the cutter spindle is carried in horizontal trunnion bearings which allow it to be tilted from 5 deg. backwards to 25 deg. forwards of the vertical position.

The inclination of the cutter is controlled by its mounting between two rollers which bear on two separate templates similarly mounted above and below the workpiece on the fixture or machine table. The roller followers are eccentrically mounted above and below the cutter, so that their setting is adjustable to compensate for the reduction of the cutter diameter in sharpening. To facilitate easy changing, cartridge type upper bearings are fitted. The cutters are usually between 3½in and 4in in diameter, with quick-tooth helix in order to permit a steady feed to be maintained on the material past the cutter spindle.

Contact between the follower rollers and the templates is maintained by two pneumatic cylinders which apply forward and tilting pressure to the horizontal slide and the cutter spindle respectively. The work fixture is fed past the cutter spindle through the medium of a feed roller on the table. The feed speeds of 8, 16 or 32 r.p.m. of the feed roller correspond to a linear fixture traverse of 5ft, 10ft or 20ft per minute. Feed can be engaged or disengaged by pedal-operated friction clutch.

Unusual Road Repair Task

WE have received details of a difficult repair job recently completed on the main coast road between Stonehaven and Montrose. In the Bervie Braes overlooking Stonehaven harbour a deep spring carried away a large part of the road during heavy rains last August. The road was shored up by a line of steel sheet piling and repaired, but a sump was built on the landward side of the road ; the problem then was to drive a 23ft long 6in pipe through from the face of the steel piles under the road. There was only a few feet of shelf at the foot of the piles, from which the cliff fell away sheer 150ft to the harbour. Various experts declined to tackle the job of boring the hole, we are informed. Mr. E. J. Moir, Kincardineshire's County Road Surveyor, finally suggested using a post-hole digger boring horizontally, and his idea was developed into practice with help from Mr. Robert Blyth, manager of the Reekie Engineering Company, Ltd.

A Massey-Ferguson 35 tractor was lowered 20ft over the side on to a short stretch of steel track on the shelf. A hole was cut into the steel piling and the post-hole auger was driven horizontally for 3ft. Special augers and extension tubes were added and the hole was slowly driven through the clay and stones. The tractor could only go back about 4ft to the cliff edge. A small tractor was essential, and it is claimed that the 35's dual clutch and the accurate position control of the tractor's hydraulic linkage (the hole was only out 1in in 23ft) made this machine specially suitable. The main modification to the post-hole digger was to strengthen the arms with extra struts. Actual drilling time took four hours, though three days was spent on the whole job. The tractor engine was run at tick-over speed, about 700 r.p.m. and the auger was eased along. If any snag was met, the engine stalled. In this way at a relatively small cost, the sump was connected and the spring diverted to the sea.

Lightweight Portable Power Chain Saw

PORTABLE power chain saws in a number of sizes and with petrol engine, pneumatic and electric drives, have been supplied to the timber industry for many years by J. Clubley Armstrong Danarm, Ltd., Abford House, Wilton Road, London, S.W.1. The most recent development of this firm is a lightweight machine, shown in the accompanying illustration, which is driven by a petrol engine, and is available with cutter bars of 18in, 23in or 28in cutting width. This machine, like all others in the range, is made for the company by T. H. and J. Daniels, Ltd., and it was recently demonstrated at that firm's works at Stroud, Gloucestershire.

The new saw, which weighs only 28 lb, is directly driven by a specially developed Villiers 100 c.c., 5 b.h.p. petrol engine. To reduce weight to a minimum, full use has been made of high-strength, lightweight materials, and by introducing a direct chain drive from the engine the weight of a gearbox, such as is normally used, has been eliminated. The weight of the machine is well balanced between the tubular front frame handle and the pistol grip rear handle on which the controls are conveniently grouped. The high-speed chain drive gives a cutting speed equivalent to 15 square inches per second when sawing dry elm.

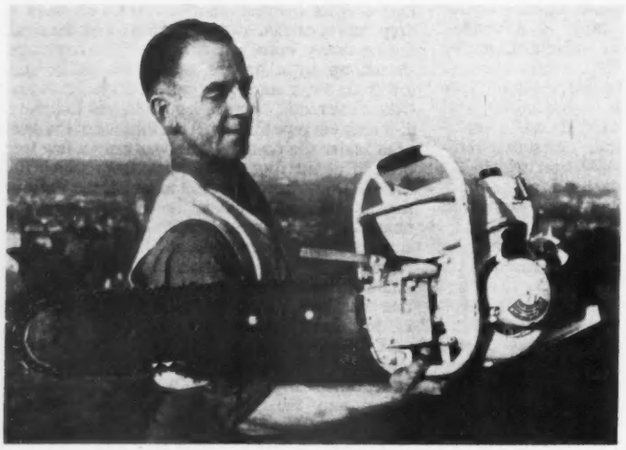
The crankshaft of the Villiers engine carries a self-locking centrifugal clutch, which comes into effect to transmit drive to the saw when the engine has developed sufficient speed for its maximum torque. The air-cooled cylinder, of aluminium alloy, has a chrome-plated bore and is fitted with a finned head with a hemispherical combustion chamber. A diaphragm carburetter, which has been developed for the engine, enables the machine to be operated at any angle and the fuel mixture is admitted to the die-cast magnesium crank case through a four-bladed reed valve. The mixture passes into the combustion space through twin transfer ports cast into the cylinder wall. A ducted centrifugal cooling fan has a die-cast "Elektron" casing on which there is mounted an automatic rewind starter engaging with the fan centre. Above the engine is a 1·6 pint fuel tank made of rigid "Polythene" plastics material.

Engine lubrication is provided by the use of a petroil fuel mixture. Engine control is effected through a finger lever in the pistol grip and during sawing this lever is fully depressed to maintain maximum revolutions, which are in the region of 5000 r.p.m. for maximum engine power.

The cutter bar of the saw—the flat plate frame round which the saw chain is supported—has a flame-hardened grooved track for guiding the chain, and a hard wearing "Stellite" surface is deposited round the nose radius at its outer end. The "chipper" design cutter links of the chain are chrome-hardened and their actual cutting sections are somewhat similar in form to small cylindrical gouges as distinct from normal saw teeth. On the link in front of each cutting section is an upstanding tongue, the top of which is a preset distance below the level of the cutting edge, and this tongue—in contacting the timber in front of the edge—controls the depth of cut. Without this control of cutting depth the teeth would dig into the wood to an excessive degree and slow down the chain and overload the engine. These cutter links are connected together by plain plate links, which support the chain on the sides of the cutter bar guide groove. Tongues on the inner sides of the chains register in the groove to maintain the alignment of the chain on the cutter bar.

To provide the necessary lubrication for the cutter chain a plunger pump delivers oil from a small tank into a well formed by two spring side plates through which the chain runs. This plunger pump is operated as required during sawing by depression of a thumb lever situated at the side of the pistol grip support.

During the demonstration of this saw it was shown how easily it could be used for cutting timber when held at any angle. In addition to normal sawing, the machine nose can be "gouged" into timber at high speed to make a cut in an outward direction if required. No practice is required to operate the saw, and having watched it in use for some five minutes for the first time we were able to take a machine over and use it effectively. A complete cut was made through a 14in diameter elm log without difficulty in less than a minute at the first attempt.



Portable petrol engine driven chain saw which weighs only 28 lb and is capable of a cutting speed equivalent to 15 square inches per second in dry elm. The 5 b.h.p. engine has a diaphragm carburetter which enables the machine to be operated at any angle

High-Speed Automatic Gauging Equipment

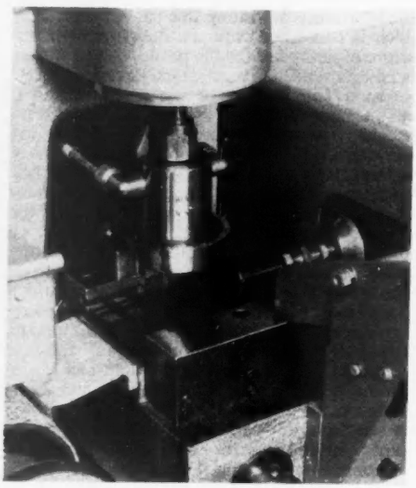
AN automatic air gauging equipment for the outer races of roller bearings, which has been built by Teddington Industrial Equipment, Ltd., Sunbury on Thames, Surrey, is designed to inspect in one operation the upper and lower internal diameters, the internal diameter taper, the upper and lower outside diameters, the outside diameter taper, and the width of a race. After these seven dimensions have been checked the races are automatically sorted into six classes—two acceptable grades, three rectification classifications, and scrap.

As can be seen from the illustration of the equipment, the setting and checking instruments are mounted on the front of the main cabinet with the inspection station on the right. A number of interchangeable gauging heads are supplied for the various sizes of bearing races to be handled, and one of the heads can clearly be seen in our second illustration. These heads use only direct jets of air for measurement purposes.

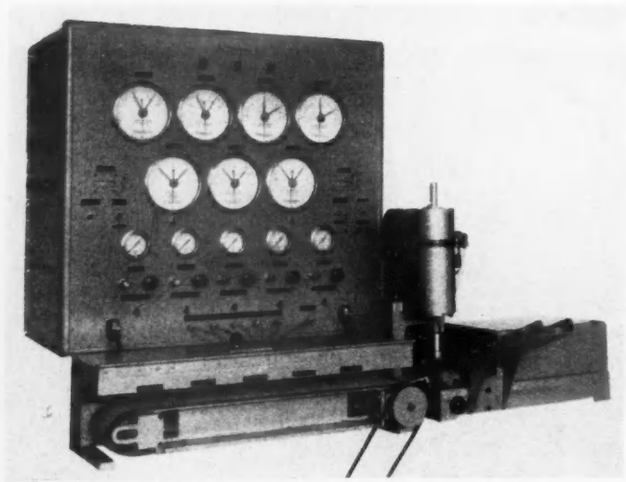
Parts are fed to the gauging head down a gravity conveyor and the cycle of operations is controlled by a sequence mechanism. Races are fed in turn into the gauging position by a horizontal pneumatic ram which positions them in a gauging block housing the air nozzles for the outside diameter and width dimensions. With the race in this position an overhead vertical pneumatic ram pushes a taper plug gauge down into the race for the measurement of the internal dimensions.

At this stage air gauging takes place and the various gauging pressures operate pressure-sensitive relays. These relays operate the switch-gear of an appropriate solenoid-operated gate for the subsequent sorting operation, after which the vertical and horizontal rams retract ready for the next cycle of operations. As the next race is loaded into the gauging position it pushes the previously checked part on to a short conveyor belt below the main cabinet. The solenoid-operated sorting gates are positioned along the side of the conveyor belt to deflect the races into the required classifications. Acceptable parts pass along the full length of the belt, but those to any of the other classifications are deflected by an appropriate gate into a side chute.

We are informed that although this equipment is engaged on inspecting 600 races an hour at present, it can achieve more than twice that speed.



Gauging head showing taper plug for internal measurements and gauging block for outside diameter and width measurements



Automatic gauging machine for roller bearing races, showing gauging unit, control panel and segregator

Industrial and Labour Notes

Nationalisation

The Federation of British Industries has published a report which reviews the arguments advanced for further measures of nationalisation or state ownership of industry and which sets out reasons for the conclusion that such measures " are not only unjustified but would bring positive harm to the country's economy." The report says that a programme of nationalisation may be examined at two levels ; first, there is the effect on the individual industries selected for the take-over and, secondly, there is the effect on the working of the economic system as a whole.

The F.B.I. acknowledges that among individual industries there are exceptional cases where some measure of public ownership or control may have been a reasonable choice. But its report shows that these cases are few in number. Whatever may be thought of the wisdom of past measures of nationalisation, it is asserted, these " exceptional cases " do not in any way bear out the claims for the general superiority of public over private ownership. They belong rather to a narrow zone of industry where public and private ownership are reasonable alternatives and where the balance of advantage may sometimes, though by no means always, fall on the side of the former.

For the economy as a whole, the F.B.I. claims, the spread of nationalisation beyond this narrow zone would undermine the foundations of its efficiency. The system of free enterprise has shown, both in this country and in many others, that it provides high and rising standards of living at all levels. Free enterprise, the report states, is an efficient system because it gives men the incentive to seek progress through more efficient ways of doing things ; at the same time it subjects them to the pressures of competition from others who seek the same end. To provide incentives for progress, it is added, there must be a prospect of reward for those who succeed in competition with others. A society which is obsessed by ideas of equality denies these rewards and therefore runs a grave risk of economic stagnation.

The report may be obtained (price 5s.) from the Federation of British Industries, 21, Tothill Street, London, S.W.1.

Industrial Relations and Welfare

The annual general meeting of the Industrial Welfare Society was held in London on Tuesday. The council's annual report, which covers the year ended June 30 last, records the various ways in which the Society's work has broadened during the past twelve months. It notes also that the Society has maintained complete independence by supporting itself wholly upon the subscriptions of its members and the revenue from its activities.

Speaking at the annual meeting, the chairman of the Society, Viscount Monckton of Brenchley, said that in the mid-twentieth century we were in the throes of a rapid industrial revolution in which science and technology were making extraordinary advances. Those advances would undoubtedly improve the economic and social outlook of millions of people if all who worked for their living worked willingly and effectively. The future era, Lord Monckton commented, was undoubtedly challenging and even exciting for those at the head of affairs, be they administrators, scientists or technologists. But, he emphasised, the challenge did not stop there. All employees in every undertaking must be given the chance to understand and share in the opportunities and in meeting the challenge ; the average man needed to feel that he belonged, that he could participate and that his abilities and skills really counted in achieving success. To achieve that, Lord Monckton added, industry and commerce would need to give unremitting attention to those essentially human questions which found expression in the work of promoting sound industrial relations, enlightened education and training schemes and wise welfare services.

Employment and Unemployment

As indicated in a recent speech by the Minister of Labour (THE ENGINEER, November 7, page 740), civil employment in Great Britain declined during September. The monthly report by the Ministry of Labour shows that the number of people at work in civil occupations was 23,100,000, a decrease of 39,000 compared with the preceding month. The main changes, the Ministry says, were seasonal reductions in the professional, financial and miscellaneous services, transport and distribution. Decreases in the cotton industry and in vehicle and metal manufacturing were offset by increases in the engineering, metal goods and precision instruments group and in some other manufacturing industries. The total number of people employed in the manufacturing industries at the end of September was 9,108,000, compared with 9,351,000 a year earlier. The engineering industries group added 3000 to its labour force during September bringing the total employed to 2,781,000, compared with 2,847,000 a year earlier.

The Ministry's report goes on to say that, in the four weeks ended October 8, the employment exchanges filled 137,000 vacancies ; the number of vacancies notified but remaining unfilled was 167,000 which was 12,000 less than in September. On October 13, there were 514,000 people registered as unemployed in Great Britain, of whom 451,000 were wholly unemployed and 63,000 were temporarily stopped. Between September 15 and October 13 unemployment increased by 38,000, the number of wholly unemployed rising by 35,000 and the temporarily stopped by 3000.

Commercial Apprenticeship

The Association of British Chambers of Commerce says that the commercial apprenticeship scheme which was inaugurated in May 1957, has made " satisfactory and steady progress during its first year." Briefly, this scheme provides for a combined comprehensive three- to five-year academic and practical training on a part-time day release or sandwich course basis for school leavers and employees between the ages of sixteen and thirty. It is administered on behalf of the Association by two Commercial Apprenticeship Boards, one for England and Wales and the other for Scotland. So far, 102 companies in the United Kingdom have joined the scheme, fifty-eight of which are in England and Wales and forty-four in Scotland. In all, nearly 200 apprentices have or are in the process of being enrolled. The latest information shows the scheme is going ahead more quickly in Scotland than in England and Wales.

The Association of British Chambers of Commerce believes that this scheme will not only contribute to the raising of standards of commercial education and training throughout the country, but will also encourage young people towards a commercial career, who hitherto, through the lack of adequate training facilities and avenues to promotion, saw their only avenue for skilled employment in a progressive career on the shop floor. During the first year actual support has come largely from the medium and large companies in manufacturing industry. Many such companies already have well developed technical training schemes, but are embarking upon commercial training for the first time. The Association says it is encouraged by the fact that companies which have entered are providing a very high standard of training for their commercial recruits, and are in fact attracting very good quality entrants to the commercial side of industry. But the Association regrets that so far little support has been forthcoming from smaller companies and purely commercial concerns ; it is hoped that during the coming year there will be signs of growing awareness among smaller companies that education and training facilities must be developed if they are to obtain a share of the best talent.

Engineering Distributors

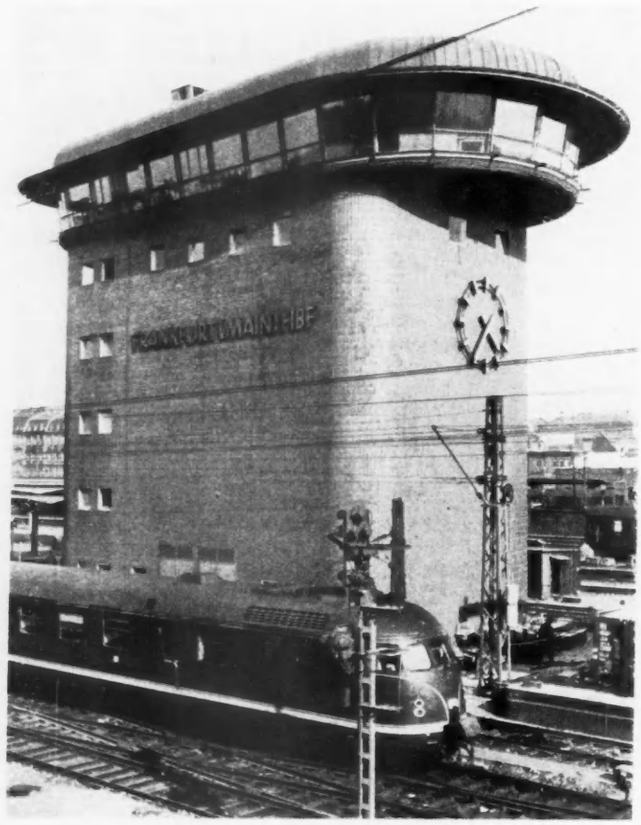
The Association of Engineering Distributors held its annual luncheon at the Park Lane Hotel, London, on Tuesday. In a speech, proposing the toast of " The Association," Mr. J. Hugh Neill, the Master Cutler, asked if the existence of the Association was necessary or desirable. As the principal aim of the Association was to protect and promote the interests of engineering distributors, he said, the answer must be dependent on whether or not engineering distributors were themselves either necessary or desirable—or whether they were superfluous middle-men who merely added to the ultimate cost to the consumer. In his opinion, said Mr. Neill, the engineering distributor was of real value both to manufacturers and consumers.

The engineering distributor performed two very important functions. For a fixed percentage, he relieved the manufacturer of the trouble and expense of selling direct to (and giving a reasonable service to) the consumer, and, equally, he relieved the consumer of the problem of having to order in greater bulk than was convenient. Each of these functions, Mr. Neill said, was worth paying so much for, and no more.

There were some users, of course, who would like to buy their bulk requirements direct from the manufacturer and, at the same price or little more, their " fill-in " requirements from a local distributor. Whether that was acceptable or not was for the individual manufacturer to decide. In his opinion, Mr. Neill remarked, the general interests of consumers required that distributors should carry, at all times, adequate stocks and should offer them at reasonable prices ; one could hardly expect this of a distributor, he added, unless he was left to handle not only the small orders but also the large ones.

New Signalling at Frankfurt

In one of the most complicated and intensely used traffic areas on the Continent of Europe a remarkable installation of modern power signalling has been put into service by the State Railway of Western Germany. When finally completed it will control Frankfurt Central Station, with nearly 6000 train and engine movements daily, and by relay-code C.T.C., seven outlying junctions will be remotely controlled and equipped with automatic point setting.



FOR many years now the need has been felt in dense and complicated railway networks for the co-ordination of the control of train movements, not merely at terminal stations and busy junctions but over the entire area, including all approach lines and interconnecting routes over which conflicting movements would pass, and would thus be liable to cause delay to through traffic. The gradual development of modern techniques in power signalling has been accompanied by concentration schemes on a limited scale, both in this country and abroad, but it was not until the completion of the large British interlocking at York in 1951 that something of the possibilities in this direction were demonstrated on any substantial scale. Then, the improvements in operation, particularly of heavy freight traffic, were so spectacular as to accelerate the consideration of many more schemes. It has now fallen to the West German State Railway to put into commission one of the most remarkable schemes of signalling concentration and control to be seen anywhere in the world, that at Frankfurt-am-Main, brought into use in the summer of 1957.

Looking at the traffic in a little more detail, the main routes leading into Frankfurt are used by German long-distance and International express trains which have to be carefully dovetailed in with other traffic at the various junctions. There is also a very heavy suburban traffic, and in the city itself an inner and an outer circle of local passenger trains is operated. Through freight trains running from north to south mostly by-pass the city, but there are still many Frankfurt-bound freight services entering the area which need some remarshalling, if not actual loading and unloading.

All railway activities in the Frankfurt area are concentrated upon the central station. It was built on its present site in 1888, and in 1912 very much enlarged to include twenty-four tracks. Its central position in the city is very convenient to the traveller, but the extreme complications in the approaches made the management of a station of this size very difficult. During each twenty-four hours a total of 1250 long-distance, intermediate and suburban trains start or terminate in the station, and in connection with these, some 4500 shunt movements are made. At the central station itself trains arrive from eight different routes, as shown in the diagram, Fig. 3; in order to avoid, as far as possible, conflicting routes outside some of these lines, those from Hanau, Darmstadt and Giessen approach over flying junctions, and the steep gradients leading therefrom extend practically to the platform ends. Thus, trains coming from certain directions are limited as to the platforms into which they can be routed, and on this account the station layout could never be used to the fullest advantage. At times of the day there would be congestion in one set of platforms, while others were unoccupied, but could not be put to good use.

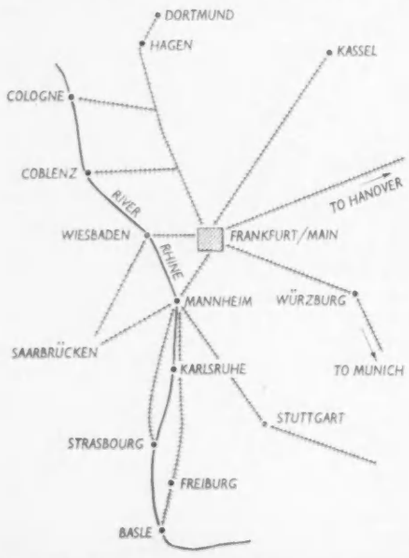


Fig. 1—Sketch map showing lines converging on Frankfurt

The immediate proximity of diverging main line junctions, giving inadequacy of space for shunting, and leading into approach lines that were often liable to become bottlenecks, has been a problem for very many years, and provides an almost classic example of the railway difficulties that can arise from an attempt to create the most central entraining point for passengers in the heart of a large community. Land for extending station facilities, or quadrupling of approach lines, is almost impossible to obtain, and so the best must be made of an exceedingly awkward situation by increasing the line-carrying capacity of the existing layout. Furthermore, while providing for the very congested central area, attention had also to be given to careful regulation of the heavy freight traffic by-passing the city, so that delays did not occur either to local or by-passing trains at the numerous points of intersection outside the central area. There was, indeed, a strong case for concentration of the supervision and control on a scale probably unparalleled anywhere in the world up to now.

The principles of relay interlocking and remote control are already well established, and in Germany the methods of accomplishment differ only in detail from what has been done in the U.K. and the U.S.A. The magnitude, in sheer numbers of operating functions, and the wide geographical area covered by the Frankfurt installation brings an exceptional interest to this work. About 600 pairs of points, and more than 700 signals, are involved, and within these large totals there are seven complete interlockings at outlying junctions that will eventually be remotely controlled from the central cabin. Provision is being made for these to be operated by a man on the spot in case of emergency, but normally these junctions will not be manned. The diagram, Fig. 4, shows the central district, and the location of the seven remotely controlled junction interlockings: Hellerhof, Mainzer Landstrasse, Gutleuthof, Niederrad, Forsthaus, Louisa, Main-Neckarbrücke. Before coming to details of the actual signalling, however, reference must be made to the chain of responsibility in the central cabin and to the layout of the operating floor in that cabin.

For a full appreciation of what has been achieved, it is necessary to examine first the railway geography of the Frankfurt area. The sketch map, Fig. 1, shows that trunk lines converge upon Frankfurt from every point of the compass, no fewer than twelve main lines in

Fig. 2—Enlarged diagram of the lines in the Frankfurt area

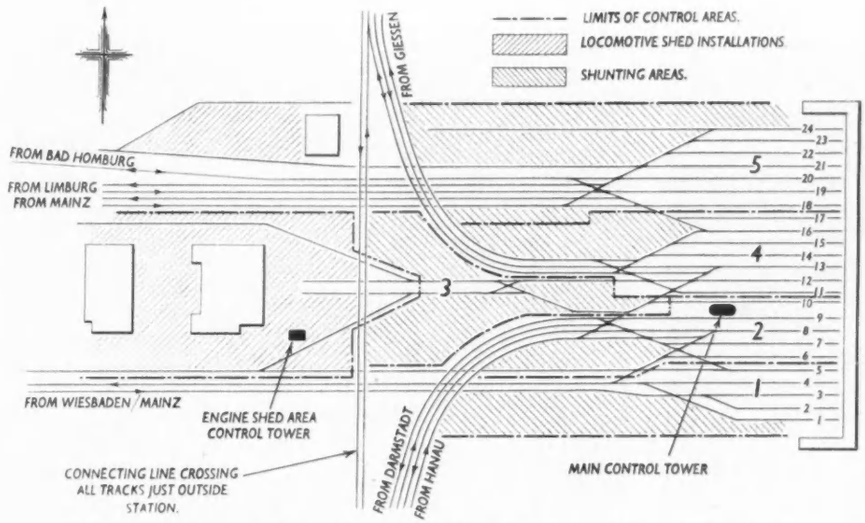


Fig. 3—The eight approaches to the central station and diagram of lines in the station

all. Nearer the city, however, there are a number of connections whereby through north to south and east to west trains may by-pass the central area, and these are shown in the enlarged scale map, Fig. 2. Connections are still more complicated in the inner district, covered roughly in a circle of 6 miles radius from the main central passenger station, and it is the control of this latter area that is now concentrated in a single box, situated at the central station.

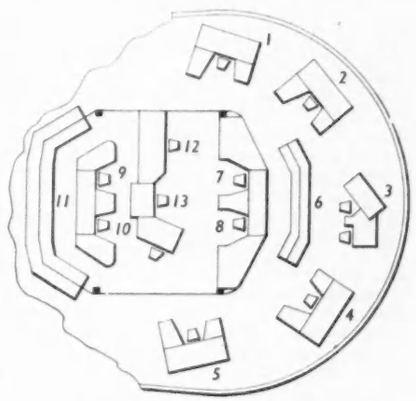
Supervision and Control

The broad conception of the new signalling scheme is based upon a chain of responsibility in three stages :

(1) Area traffic supervisors, who between them control the traffic in the whole Frankfurt area ; (2) Station traffic supervisors, who keep watch on the overall working in the station and its immediate approaches ; (3) The station signalmen. Each group of operators is provided with illuminated diagrams of the most comprehensive kind, giving not only a geographical representation of all tracks in the areas concerned, and the occupancy of track circuits by means of indication lights, but the actual timetable reporting numbers of the trains themselves are shown illuminated on the diagram. Thus the position of any individual train in this extensive area can be pin-pointed, so to speak, at any time. This system of indications not only eliminates the old conventional type of block telegraph communication, but the more recent systems of train description, on which the classes of incoming trains are shown on separate illuminated indicators. Even the more modern of the systems of train description would have been complicated to apply in an area of the size and diversity of that controlled by the new signalbox at Frankfurt.

Co-ordination of all operators working in the area is achieved by having all those concerned not merely in the same building but in the same room. The accompanying diagram, Fig. 5, shows the relevant section of the operating floor of the new signalbox. The station area is divided into five sections, each having its own signalman and control panel. In making this division consideration was given to the number of train movements in each, so as to give, as far as possible, an even distribution of the work. Fig. 3 shows the division of the station area, as between the five panels. The number of shunting movements was the main consideration. Eight shunting locomotives are continuously in service at the station, and assigned to certain duties they have no more than limited spheres of operation. As far as possible it is attempted to keep the majority of these locomotives to the area controlled by a single panel. Although with a modern illuminated diagram the signalman himself does not need to see the actual trains there are loudspeaker operators, stationed between the panels, who need to have a comprehensive view, and the high building, with the floor of the operating room overhanging, as shown in the heading illustration, gives an exceptionally clear look-out. Another engraving, Fig. 7, shows a close-up view of one of the panels and in the left-hand end of this will be seen the rectangular panels on the tracks, in which the timetable numbers of individual trains are illuminated.

The central panel of the five, No. 3, might from our diagram, Fig. 3, appear to have the lightest task, but it is actually one of the busiest of all. Its duty is to deal with the very numerous engine movements between the station and the nearby running sheds where a separate control cabin has been installed. From the two roads leading into the sheds, there is direct access to no more than half the station lines ; to reach the others some reversing movements are needed, and interchange of workings with the



1–5	Control panels for operating signals and points in the station area.
6	Recording panel, on which the signal regulators observe, with the aid of illuminated indicators, all incoming and outgoing trains.
7 and 8	Control desks for the signal regulators.
9 and 10	Control desks for regulating officers, who direct traffic on the outlying and approach sections.
11	Illuminated diagram of outer area.
12	Train announcer.
13	Chief station supervisor.

Fig. 5—Layout of operating room in the control tower

Abzw—Junction.
Hpbf—Central station.
Ffm—Frankfurt on Main.
Ff—Frankfurt.
Rw—Shunting tower.
Fpf—Frankfurt (M) ; main control tower.

Fig. 4—Detail of lines in the central area

neighbouring signal panels 2 and 4 (see Fig. 3). During a normal day's work no fewer than 2400 engine movements are controlled from this panel 3 alone.

Immediately behind the five station signalmen are the two station area traffic regulators. Their platform is on a higher level than that of the signalmen and gives an over-riding picture of the station approaches and of operations on the five signal control panels. The regulators also have a large illuminated diagram ahead of them, but designed to show only the approach and departure of trains on the various tracks by display of the timetable train reporting numbers, rather than the details of track occupancy, indication of signals, and the lie of points that are essential on a signalman's control panel. The two regulators decide on the priorities to be given to ingoing and outgoing traffic, and instruct the signalmen accordingly. Except in the visual indicating of the train numbers, both on the signal control panels and on the regulators' panel, the method of working in the station and its immediate approaches is not greatly different from what has been accomplished at some of the largest modern power interlockings in this country. It is in the treatment of the outer area that the signalling in the Frankfurt district marks so decided an advance.

Control of the Outer Area

With so large and complicated a system of approach and by-pass lines as exist around

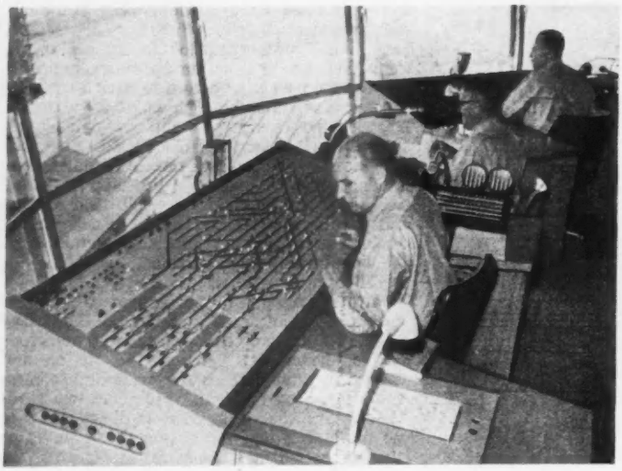


Fig. 7—Close-up view of control panel for station tracks

Fig. 8—Inner section of control room with outer area regulator and district supervisor

Frankfurt it would be impracticable, as well as undesirable to attempt to display on a single illuminated diagram all the detail associated with a panel in which a signalman is in direct control. The regulators in the central box at Frankfurt can exercise no more than a general overriding supervision, with only two men watching over seven remotely controlled junctions, and traffic on the intervening lines. The work has been greatly simplified by the introduction of relay-code remote control, between the central box and the outlying junctions, and by a system of automatic point setting, which obviates the need for any action by the outer area supervisors in the central box—unless, of course, some overriding control is desired. At each of the seven outlying junctions the interworking of all signals and points is fully interlocked in accordance with well-established safety principles, and the cabin equipment is such that it could be taken over by a man on the spot, and worked locally in some emergency that might disrupt or otherwise make impracticable the remote control from the central box. Ordinarily a relay-code system of C.T.C. is employed, with control and indication codes conveyed on two line wires. The time of coding is approximately one second, for a control or indication code.

With C.T.C. in the normal way, the controller at the remote point has to send a code, and himself make a movement, each time a pair of points has to be changed, or a signal cleared. To reduce to a minimum the number of actual movements to be made by the outer area supervisors at Frankfort, and so to make available to them a maximum of time for watching the progress of train operation generally and thus be in a better position to anticipate likely delays, or imminent congestion, a system of automatic point setting has been introduced at the outlying junctions. Connected with the visible indication of the train numbers on the various illuminated diagrams is a direction indicating device which sets the points in accordance with the route of the oncoming train. The automatic working of this system takes no account, of course, of the priorities of trains, and the points are set on a "first-come, first served" basis, having full regard, of course, as to whether the route in question is available through the signal and point interlocking circuits. If the route should not be immediately available, or if two trains should approach a converging or intersecting point simultaneously, their route indications are stored, and registered for point setting as and when track conditions permit. If necessary the outer area supervisor in the Frankfurt central signalbox can always intervene, and hold a train for one of higher priority that is approaching, or in any way dispose traffic at the outer junctions to his requirements. In the ordinary way automatic working prevails. In the near future we hope to publish in THE ENGINEER full details of the working of this automatic point setting system. In the central signalbox, as shown in our engraving, Fig. 8, sits the traffic superintendent of the entire area, including the station. He is conveniently situated, as shown in Fig. 5, between the outer area supervisors, and the station area regulators, and can exercise any special co-ordination that may be required. Beside him is the lady announcer for the station loudspeaker system.

Operating Room Design

One of the difficulties attendant upon the concentration of railway operating control, such as that represented by the new plant at Frankfurt, is the diversity of tasks to be performed in a single room. Inevitably, in an area where so many shunting movements are involved there must be frequent loudspeaker communication between signalmen and the yard, and vice versa ; the station regulators will wish to talk to the signalmen, on occasions, and there will be many other conversations, backwards and forwards, to say nothing of the announcements made to the station platforms and concourse by the public address system. In some large signalboxes both in this country and abroad the babble of words, both co-operative and perverse, can rise to a very high pitch, and in Frankfurt, from the outset it would seem that very careful attention has been given to the acoustic design of the box, even to the extent of laying a carpet on the floor. To minimise noise from outside double windows are fitted, kept permanently closed, with the room itself completely air-conditioned. Sound-proof material is used in ceilings and walls, and reverberation and echo minimised by the avoidance of parallel running walls.

With telephone and loudspeaker equipment installed on every desk, the risk of much confused noise was considerable, but very great care and much experiment was devoted to the regulation and positioning of the numerous instruments. On every desk there are two loudspeakers, one for communication with other operating personnel, both inside and outside the room, and a second for communicating with the shunting service. The noise coming from these loudspeakers was regulated so that only the operator concerned was able to hear and make himself heard. This was achieved by the use of sound compensated microphones, supported on flexible rods for easy reach. The German railway authorities were evidently well aware of the widespread interest this installation would arouse, and the number of visitors they would receive in consequence. To avoid as far as possible the need for conversation and explanations when such visitors were being shown round a separate room has been set aside on the fifth floor of the signalbox, and equipped with maps, charts and so on, where the working can be explained by the official guides before the parties are taken into the actual operations room. A measure of the success with which these noise reducing devices have been attended is seen in the position occupied by the train announcer ; she sits out in the open room, whereas in some modern signalboxes the announcer sits in a sound-proofed cubicle.

As in the majority of modern signalboxes the operating room occupies a very small space in comparison with that taken up by the control equipment.

Besides the operations floor, 18m above the ground, there are five other floors and a basement. Immediately below the top floor are the switches and relays for wireless loudspeaker and telephone communications. The third floor houses the switch and relay panels for remote control and the illuminated train number diagram with 37,000 relays, the second and first floors contain the interlocking switches and relays, some 15,000 in number, of the control panels for the main station. On the ground floor and in the basement are located the transformer substation, two diesel emergency generating sets, the main battery, converters, switchboard and other items of the electricity supply.

Installation and Changeover

Engineers engaged in the practical task of changing over older forms of signalling to the latest modern designs will be especially interested in the programme of conversion followed through at Frankfurt. The order for construction of the necessary equipment and its installation was placed with the firm of Siemens and Halske A.G., Wernerwerk für Signaltechnik, Brunswick, in 1954. Simultaneously certain civil engineering works in connection with track and station layout improvements were put in hand. Work began on the building of the new central signalbox in March 1955, and at the same time there began the lengthy job of cable running. Within a space of two years about 120 miles of cable had to be laid. The date determined for the putting into service of the new signalbox, which began on June 29, 1957, was settled, in fact, some four years previously to coincide with the commencement of electric traction in the Frankfurt area. So far as the contractors were concerned, account had to be taken of the time expected to be required for the acceptance testing by the railway authorities. A period of four months was set aside for this. The switching over was carried out in six stages, each one at a weekend. The most elaborate preparations had been made for minimising train movements during the changeover period, and during the first three days following the complete change-over of the Northern and Southern halves of the station on July 28 and August 11, a large number of the business trains were terminated at one or other of the suburban stations, from which public transport to the city centre could readily be obtained. In this way conditions were made easier for the operating staff while they were gaining familiarity with the new equipment.

At the present time not all the outlying junctions have been brought into the remote control system, nor has the automatic point equipment been installed at all of these ; but the final plan covers the entire area with these facilities.

The American Scene

BY OUR AMERICAN EDITOR

Higher Fidelity

The High Fidelity Show held in New York last month gave most of the spectators their first opportunity to hear something called stereophonic sound: the re-creation of music with virtually the realism of the concert hall. The response was enthusiastic. Even before " stereo " records and equipment were available, in fact, the American public had been besieging music stores and component dealers and clamouring for them. The growing demand clearly is good news for the already thriving makers of high fidelity equipment. From the early 'fifties, when " hi-fi " first emerged from the workshops of the hobbyists, sales of components have been growing steadily. According to the Institute of High Fidelity Manufacturers, retail volume soared from 27,000,000 dollars in 1951 to more than 200 million dollars last year. Moreover, despite a virtual halt in sales early this summer, when the public decided to wait for the new stereo equipment, they are expected to top 250 million dollars this year. In 1959, the industry is confident that the stereo boom will carry them far beyond that. Exactly what constitutes high fidelity is something no two music lovers will agree on. Stereo inevitably has added to the confusion. A study group of the Audio Engineering Society, for example, has been working for several years, with no conspicuous success, on an acceptable definition, and on standards of manufacture. In essence, however, high fidelity is simply the faithful re-creation of sound. The average human ear, it is believed, can hear vibrations ranging from 30 to 15,000 c/s, and an unusually keen one may detect those from 20 to 20,000 c/s. Ordinary gramophones, however, reproduce only sounds between 100 and 6000 c/s, and that with considerable distortion. They cannot capture either low bass notes or the highest treble. High fidelity equipment reproduces this entire sound spectrum, with relatively little distortion. This is accomplished through the use of several matched components. The components include a record player, a tone arm, a magnetic cartridge and diamond needle, and/or a tape recording-reproducing deck ; an amplifier and a preamplifier ; and a speaker system, consisting of a " woofer " for the low notes and a " tweeter " for the high ones. There may be either a single " co-axial " speaker or two separate ones in a resonance box. Besides these essentials, it also may include the tuning mechanism of a wireless and a television set, so that the sound from each also will be reproduced with absolute fidelity. These various combinations, purchased separately, may cost as little as 200 dollars or as much as several thousand dollars. The industry that produces all this equipment in America to-day subdivides into two distinct parts. By far the larger one, dominated by the major radio and electronic concerns, assembles the various components in the factory and sells them as a packaged unit. The other is the component end, where manufacturers turn out amplifiers, preamplifiers, tuners, record changers and turntables, speakers and enclosures and sell them individually. Among the producers of packaged sets are such giants as Radio Corporation of America, Philco, Zenith and Magnavox. In the field of components, well over 100 companies compete for the hi-fi dollar. Almost no companies make a full range of components ; each specialises in one or two. David Bogen, for example, makes amplifiers, preamplifiers, combinations of the two, and tuners, while its Presto division makes turntables ; Bell Sound Systems makes amplifiers, preamplifiers and tuners ; Heath produces amplifiers, preamplifiers and tuners in kit form for the " do-it-yourself " market ; Altec-Lansing turns out amplifiers, preamplifiers, speakers and tuners ; Gray makes only turntables and tone-arms and Jensen only speakers.

Like many another young American industry, high fidelity is a direct outgrowth of World War II. Just prior to that, many sound engineers in recording studios and broadcasting companies, dissatisfied with the reproduction then available, began experimenting with more sensitive equipment. By 1946, home-made high fidelity sets began cropping up throughout the land. The only thing lacking, since the old 78 r.p.m. records were notably low-fidelity, was something to play on them. The long playing record, which was introduced in 1948 by Columbia Records, partially filled that gap. For a long time, though, high fidelity was limited to a small group of enthusiasts. The components were expensive, fairly difficult to assemble, and, in many communities, hard to find. About five years ago, however, the industry got its big boost in the mass market. Columbia introduced a low-priced table model gramophone, which gave a fidelity of reproduction unknown in inexpensive instruments at that time. R.C.A., Magnavox, Philco, Zenith, Ampex and others followed, with everything from inexpensive table models to costly consoles. Since these instruments reproduced well and many were far cheaper than separate components, they seemed to offer a major threat to the latter. They proved, however, to be only a spur. The true American audiophile, of course, would never consider buying a packaged set. Beyond that, a wider area of the public also began to hear and understand music for the first time, thus opening up an untapped market for components. The public soon discovered that, for under 200 dollars, it was impossible to purchase components as satisfactory as a packaged set. Above that price, however, an equal sum spent for the two would result in far superior components. For people with limited space, components which could be stuck away in a cupboard or any unused area proved ideal. They also could be changed and replaced whenever anything new came out. Finally, the component hi-fi system began to become a symbol of status. Once components moved out of the audiophile area, however, marketing problems inevitably arose. Since most of the sets were distinctly unattractive, the companies quickly called in furniture designers to revamp them, and began advertising in consumer publications. Then, there was the problem of distribution. Components had been sold mainly through radio parts shops in out-of-the-way spots in major cities. In New York these shops are centred in the Cortland Street area, much as they are in London in the Charing Cross Road. As the hi-fi boom progressed though, some enthusiasts began opening shops in suburban areas handling nothing but components and selected records. To-day there are more than 3000 such outlets in the United States, in almost every city of any size. With the backing of manufacturers, they have continued the practice of selling components at wholesale prices, the so-called " audiophile net." This has been accomplished through the elimination of the distributor ; components are sold directly to the dealer by the manufacturer and then to the public.

For a time, the industry was concerned over the fact that, because of the lack of any adequate standards, every gramophone was being sold as " Hi-Fi." As the public became more sophisticated about sounds, this worry quickly vanished. The industry has found that anyone who buys a gramophone is a good prospect eventually for components. Stereo, of course, opens up an entire new field for the component producers, since stereophonic reproduction calls for several refinements in the basic hi-fi system. On conventional gramophone records, sound is recorded on a single channel. Thus it can be picked up by an ordinary needle and transmitted by one amplifier to one speaker system. In stereo, the music or sound is recorded on two vertical channels in the record groove, and its reproduction requires a specially designed needle, tone arm and cartridge and a second amplifier. It also requires either a preamplifier which can control both amplifiers and the necessary second speaker or a stereo-adapter. Most hi-fi components sold in the past can be converted to play stereo records ; all monaural records, for that matter, will sound better on a stereo set. Stereo did not arrive on the scene unheralded. As long ago as 1953, Bell Sound Systems was in production of a two-channel stereo amplifier-preamplifier designed to play the few records available then. By January of this year, however, it became apparent that stereo records would be appearing in large numbers by this autumn. Hence all the component producers began adapting their equipment to the new medium. By late summer, most had begun despatching their first stereo units. The cost to the high fidelity owner of converting to stereo depends entirely on the equipment he already owns and on what he adds. The man who has no equipment at all, or who desires to replace everything except speakers and turntables (which need no alterations), can buy a stereo preamplifier-dual amplifier combination for about what he would have spent for a monaural combination. The high fidelity fanatic, of course, is not content with any combination, but wants each unit separate. Thus, he may prefer a stereo preamplifier distinct from his own amplifiers. If the excitement stereo has aroused in the public persists now that it is becoming generally available, the hi-fi industry will get an enormous lift. And there is every indication that enthusiasm will continue. Most of those who now have component high fidelity—an estimated 3,000,000 persons—presumably will be eager to buy at least the conversion equipment, speakers and amplifiers. Beyond that, manufacturers and dealers alike are hoping that a new crop of audiophiles will come along, now that, as one enthusiast puts it, " music has taken on a third dimension."

Hot Exponential Facility for Nuclear Reactor Development

ONE of the nuclear industry's most serious difficulties is its dependence on theoretical calculations to determine reacto: behaviour under actual operating conditions. The Babcock and Wilcox Company expects to place this phase of power reactor technology on firmer ground through the use of a combined research and test reactor and " hot exponential " facility which the firm recently began operating at its Critical Experiment Laboratory in Lynchburg, Virginia. Tne new unit will provide American industry with a means of determining accurately how reactor cores will behave at operating temperatures. In the past, reactor behaviour for these conditions has been determined by calculations based on experiments at room temperatures. Now, with this new facility reactor characteristics at high temperatures can be measured.

Designed by the Atomic Energy Division of Babcock and Wilcox, the researcn reactor will be operated at a nominal power of 10kW. The reactor, however, is capable of powers up to approximately 200kW. It will serve primarily as a neutron source for tests which will be conducted in the exponential facility. The reactor pool is essentially an open concrete shell 7ft by 13ft by 18ft and will be filled with highly purified, demineralised water. The reactor will also be employed for reactor physics experiments, neutron beam experiments, reactivity testing, and nuclear quality control of materials. The core is situated at the same end of the pool as the exponential facility and will consist of an upright assembly of sixteen plate-type fuel elements of uranium-aluminium alloy containing 30 per cent by weight of enriched uranium. Shown in Fig. 1 is a technician using a long metal grapple to move a fuel element from its storage vault. The vault is built into the pool bottom to the grid plate, which serves as a base for the reactor core. The partly-assembled core rests under water, and may be seen directly beneath the bridge. The long tubes emerging from the core house control rods and special instruments. Tne exponential facility is essentially a pressure vessel, 3ft inside diameter by 9ft. long. It is designed to duplicate reactor operating temperature and pressure conditions. As shown in Fig. 2, a hydraulically-operated, quick-opening door at the outer end permits rapid and frequent access to the test assemblies inside the vessel botn for the prompt removal of testing equipment and the re-arrangement of core assemblies.

During test operations, a sub-critical assembly of fuel rods is placed in the vessel, together with wires which record the neutron distribution along the axis of the fuel rods. The vessel is then filled with water. An external heater and pressuriser produce operating conditions up to 500 deg. Fah. and 720 lb per square inch of pressure. The adjacent reactor serves as a neutron source for the test assembly. A boral gate minimises reactivity coupling between the reactor and tne assembly under test. After the wires have been exposed to neutron bombardment within the assembly, they are removed and their radioactivity is measured on an automatic scanning device to determine both the radial and longitudinal neutron flux distribution throughout the assembly. The neutron distribution is known to fall off exponentially along the axis of the assembly, giving rise to the name " exponential facility."

Believed to be the first commercial installation of its kind in the nuclear industry, a " Teleflex " wire activation system, based on a design by the Knolls Atomic Power Laboratory, of the General Electric Company, is a vital part of the exponential facility. Neutron flux measurements at high temperatures and pressures are now possible without the requirement for first lowering the temperature or opening the exponential facility door to remove test material. As utilised by the firm, the " Teleflex " system consists of a drive mechanism which directs eight dysprosium-aluminium wires, 0·020in in diameter and encased in hollow titanium flexible cables, into stainless steel conduits leading into the exponential facility. Following a predetermined exposure to neutron bombardment from the reactor core, the cables are withdrawn and the exposed wires removed. The wires are then attached to a 27in diameter power-driven wheel or " scanning drum." An electronic timer rotates the aluminium drum and causes it to stop for a predetermined time for " counting " purposes. A scintillation detector measures the gamma radiation emitted by the wires. A digital printer translates the impulses either on tape or on an IBM punched card system. The reactor operating test conditions are thus automatically classified for subsequent analysis by nuclear physicists with an electronic computer.

The new reactor and hot exponential facility unit is housed in a newly constructed bay of the Critical Experiment Laboratory, which was the first such American laboratory to be licensed by the Atomic Energy Commission and built entirely with private funds.

Large Trenching Machine

THE accompanying illustration shows a trenching machine now being made by the Parsons Company (a division of the Koehring Company) of Newton, Iowa, which is known as the Parsons 420 " Trenchliner." The machine will excavate trenches up to 7½ft deep, with widths of 36in to 52in, at digging speeds of 15in to 25ft per minute.

The large excavating wheel is cantilevered out behind the machine and between its caterpillar tracks, as the illustration shows. The depth of the wheel is adjusted by double-acting hydraulic jacks, one of which can be seen. The wheel has three operating speeds, viz. 115ft, 215ft and 300ft per minute, and the bucket widths may be either 36in, 42in or 48in. Digging widths of 40in, 46in or 52in may be obtained by using sidecutters ; the bucket teeth are replaceable.

Material picked up by the buckets of the wheel

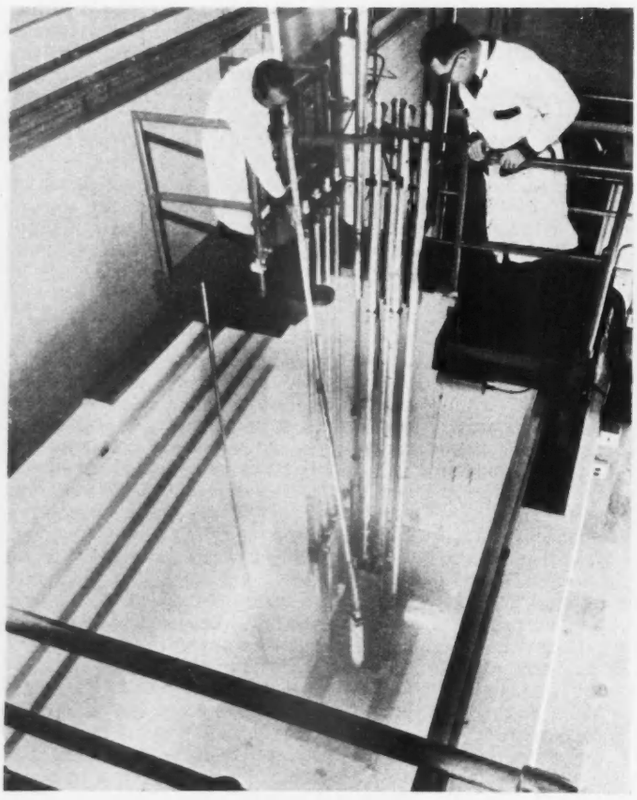


Fig. 1—Manipulation of fuel elements in hot exponential facility at Lynchburg, Virginia

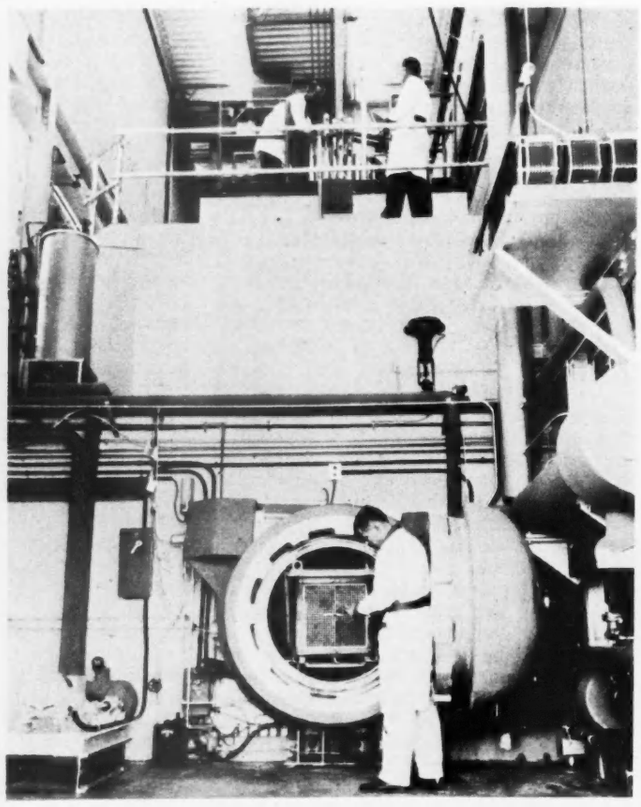


Fig. 2—Pressure vessel of hot exponential facility with hydraulically operated door

The Parsons "Trenchliner" can excavate a trench up to 4ft 6in wide by 7ft 6in deep at speeds up to around 2 m.p.h.

is deposited on to a conveyor belt, which is also clearly shown in the illustration, the "delivery" end being supported by a boom and the wire. The conveyor belt is reversible, and may run at speeds of 193ft, 378ft and 621ft per minute.

The "Trenchliner" weighs about 42,000 lb. Its crawler tracks are 24in wide and the travelling speeds of the machine range from 1 to 2·5 m.p.h. The power unit is a 120 h.p., 1500 r.p.m. International Harvester diesel engine.

Combination Strip and Powder Rolling Mill

THE development of a heavy-duty, high-precision, two-high/four-high combination rolling mill for application in metallurgical production and research work has been announced by the Loma Machine Manufacturing Company, of New York. The major aspect of the new machine is its convertibility from a conventional vertical strip mill to a horizontal mill used in the compacting of metal powders into sheet and strip. As shown in Fig. 1, the machine is equipped with particularly large mill housings, roll journals, universal spindles and drive transmission. This heavy-duty design allows the mill to take reductions of more than 50 per cent per pass while maintaining tolerances as close as 5 per cent of thickness. The change-over from the 8½in by 8in two-high to the 2½in and 8½in by 8in four-high set-up requires only thirty minutes. The two-high arrangement is used for either hot or cold break-down rolling of plate and sheet, and grooved rolls are also available to process rounds, squares and other shapes. In the four-high set-up strip is cold finish rolled to gauges as thin as 0·002in. The optional conversion feature allows this versatile mill to be arranged also in the horizontal plane for the direct compacting of powder into sheet and strip, as shown in Fig. 2. For such a metal powder rolling operation, a special feed hopper, a powder entry guide and an exit chute are applied to the 8½in diameter two-high rolls, which can produce compacted materials up to ⅛in thick.

The compacting-by-rolling technique is, in principle, quite simple. The metal powder is merely poured between the revolving rolls and a solid, uniform mass is produced. Several variables such as roll diameter, roll gap and roll speed, determine the strip qualities. Only a small amount of trial-and-error experimentation is required to achieve desirable strip formation of a given metal powder sample. Different methods of introducing material to the rolls may be employed by various hoppering techniques aided by vibrators, to obtain a uniform feed rate. Laminations may be produced by directing streams of dissimilar powders into the roll gap. Powder may also be compacted between strips of wrought metal to form a "sandwich" as is sometimes done in the manufacture of certain types of nuclear fuel elements. Impregnation of cloth with powder has been successfully carried out. Initial experimental feeding may also be done manually, with hoppering added to obtain high production. The width of the strip is controlled by side platens which are adjustable over the width of the rolls, enabling the formation of strip from ¾in up to almost the face width of the compacting rolls. The material thickness is determined by the roll diameter to a great extent and also by the screw-down setting which controls the gap between the rolls. Certain powder samples are produced in strip thicknesses corresponding very nearly to the opening between rolls, whereas others may have twice or three times the thickness measurement of the roll gap through which the particles were fed. Practically all metal powders compacted into strip must be sintered within a protective atmosphere such as hydrogen or argon, to increase strip strength and ductility. The process is usually completed by rerolling the sintered strip in either a two-high or four-high mill set-up.

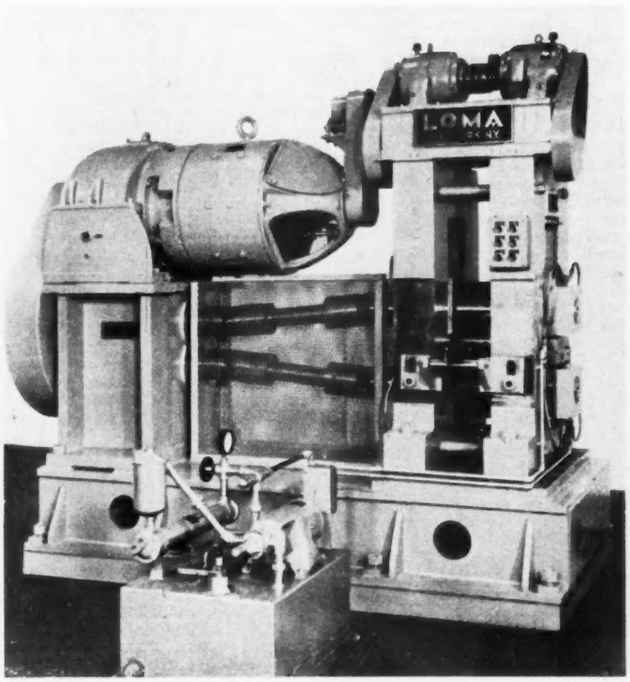


Fig. 1—Vertical arrangement of "Loma" 2½in and 8½in by 8in two-high/four-high combination rolling mill

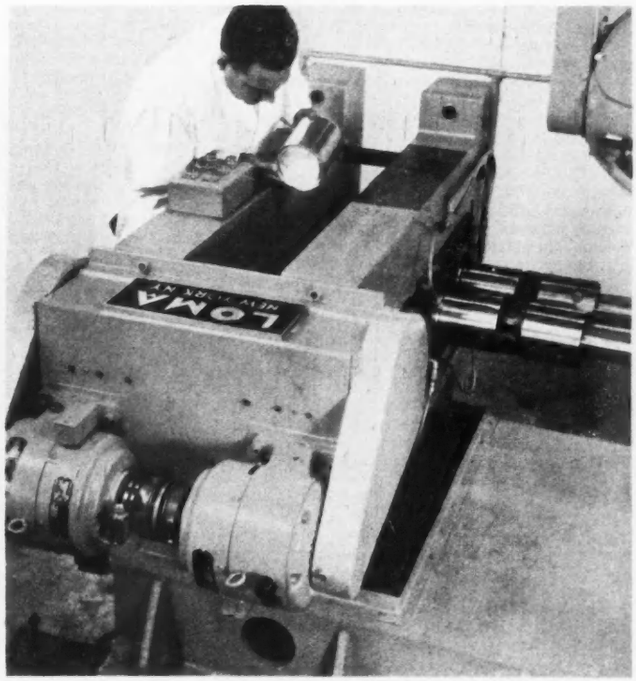


Fig. 2—Horizontal two-high mill arrangement set up for the direct compacting of powder into strip

Personal and Business

Appointments

MR. E. W. BARTON has been appointed a director of W. M. Still and Sons, Ltd.

MR. JOHN SMITH, M.I.Mech.E., has been appointed technical director of Petters, Ltd.

COCKBURNS, Ltd., announces that Lieutenant-Commander Jack Tinneveld has been appointed a director.

MR. ARTHUR GRIFFITHS, M.I.P.E., has been appointed group managing director of Sterling Industries, Ltd.

MR. R. YEOMAN has been appointed a director of A. B. Scorer, Ltd., a subsidiary company of James Hodgkinson (Salford), Ltd.

MAJOR-GENERAL E. P. READMAN and MISS V. A. PEASE have been appointed directors of Amber Chemical Industries, Ltd.

SIR RICHARD YEABSLEY has been appointed chairman of the Ruberoid Company, Ltd., in succession to the late Mr. Davis L. Irwin.

MR. M. H. SAYERS, A.M.I.Mech.E., has been appointed apprentice training manager of F. Perkins, Ltd., in succession to Mr. J. Talbot.

FERODO, Ltd , has announced that Mr. J. Holdgate has been appointed purchasing manager in succession to Mr. J. W. Heathcote, who has retired.

MR. DAVID E. BURTON has been appointed to be in charge of the London technical sales department of Rocol, Ltd., Ibex House, Minories, E.C.3.

MR. C. P. SEAGER has been appointed industrial truck sales manager of Ransomes Sims and Jefferies, Ltd. He will be assisted by Mr. J. E. Ovell.

SOLARTRON ELECTRONIC GROUP, Ltd., announces that it is forming a subsidiary company in Sweden, which will be managed by Mr. Kurt P. Källgren.

WRIGHT'S ROPES, Ltd., states that Mr. E. P. Smith has been appointed a director. Mr. W. L. Ross has been appointed a director of the Rollason Wire Company, Ltd.

MR. J. W. PLOWMAN has been re-elected chairman of the British Valve Manufacturers' Association for the year 1958–59. Mr. N. P. Newman has been re-elected vice-chairman.

MR. E. CARS has been appointed a director of the Moss Gear Company, Ltd., in succession to Mr. A. W. Macferson, who has relinquished the position to take over the duties of sales director.

THE TEES SIDE BRIDGE AND ENGINEERING WORKS, Ltd., announces that Mr. Francis Cox, chief production engineer, has been appointed production director, and Mr. Stanley D. Hodgson, assistant manager, has been appointed technical director.

MR. K. E. SHUREY has been appointed deputy group publicity manager of C. C. Wakefield and Co., Ltd. Mr. John C. Edmunds has been appointed assistant publicity manager (Castrol and Agricastrol). Mr. Laurence Sultan has been appointed group public relations officer.

MARCONI'S WIRELESS TELEGRAPH COMPANY, Ltd., announces that Mr. F. N. Sutherland, M.I.E.E., has been elected to the board of directors and has been appointed managing director. He has also been appointed a director of Marconi Instruments, Ltd. Mr. Paul de Laszlo has also been appointed a director of both companies.

PHILLIPS ELECTRICAL, Ltd., has announced three appointments to take effect from January 1 : Mr. Hector Thorne to be a personal assistant to the managing director, responsible for market development ; Mr. W. F. Cassidy to be general regional manager, south-east region ; and Mr. D. E. Beard to be regional manager, Midlands region.

METROPOLITAN-VICKERS ELECTRICAL COMPANY, Ltd., has announced the following appointments :—Mr. C. F. Saunders, A.M.I.E.E., chief engineer, standards department ; Mr. G. H. Moule, chief engineer, heating and welding department ; Mr. R. F. Mansfield, A.M.I.E.E., assistant sales manager, industrial control department, and Mr. F. Crowther, A.M.I.E.E., assistant chief engineer (design), industrial control department.

CROMPTON PARKINSON, Ltd., has announced the following appointments :—Mr. C. A. J. Martin is relinquishing his position as general sales manager and has been appointed an executive director free for special duties. Mr. K. Younger will become general sales manager, plant division ; Mr. A. Morris becomes manager, London branch, plant division, and Mr. C. E. Hucker has been appointed manager, Cardiff branch, plant division.

THE DE HAVILLAND AIRCRAFT COMPANY, Ltd., has announced the following appointments : Mr. F. H. M. Lloyd, A.F.R.Ae.S., has been appointed sales manager ; Mr. J. A. Grace, commercial manager ; Mr. N. G. E. Dunlop, assistant commercial manager ; Mr. J. C. Corby, assistant sales manager ; Mr. P. F. L. Hall, F.R.Ae.S., technical sales manager ; Mr. P. P. Hearle, assistant to the sales manager (general duties) ; Mr. H. Shaw, assistant to the sales manager (airline liaison), and Mr. P. G. Lucas, F.R.Ae.S., assistant to the managing director.

Business Announcements

THERMALITE-YTONG, Ltd., states that its second factory at Hams Hall, near Birmingham, is now in full production.

ABERDARE CABLES, Ltd., and SOUTH WALES SWITCHGEAR, Ltd., have established new offices in Rex Buildings, Wilmslow.

W. AND J. R. WATSON, Ltd., has moved from Great King Street to "Romano House," Station Road, Corstorphine, Edinburgh, 12 (telephone COR 2311).

THE MIDLAND COIL WINDING COMPANY, Ltd., has moved from Lancaster Street, Birmingham, to a new factory wing in the Pensnett Trading Estate, Brierley Hill, Staffs.

THE BRITISH THOMSON-HOUSTON EXPORT COMPANY, Ltd., is now located at 33, Grosvenor Place, London, S.W.1 (telephone Belgravia 7011), having transferred its offices from Crown House, Aldwych.

CLARE COLLETS, Ltd., announces that it has appointed Messrs. Stuart and Houston, 5, York Street, Glasgow, C.2, as its sole agent for "Clare" milling equipment for the whole of Scotland.

THE SOLARTRON ELECTRONIC GROUP, Ltd., Thames Ditton, Surrey, has concluded selling and manufacturing licensing agreements for "Kintel" electronic products of the Cohu Electronics Inc., of San Diego, California, U.S.A.

Contracts

JOHN LAING AND SON (S.A.) (PTY.), Ltd., has been awarded a contract, worth nearly £500,000, to construct a 39-mile road in South-West Africa. This trunk road from Otavi and Tsumeb in the north of the territory will be built in thirty months. The contract includes many bridges and culverts.

JOHN FOWLER AND CO. (LEEDS), Ltd., has received an order from South Durham Steel and Iron Company, Ltd., for ten type 0–6–0, 4ft. 8½in gauge, 230 b.h.p. diesel-hydraulic-mechanical shunting locomotives, each 35 tons in working order, and having an initial tractive effort of 21,000 lb. These locomotives will embody Leyland/Albion four-stroke diesel engines, Schneider single-stage torque converters, and Wilson two-speed, air-operated, epicyclic gearboxes, and forward and reverse air-operated final drive units. The torque converter and transmission will be supplied by Self-Changing Gears, Ltd., Coventry, which company, with Leyland Motors, Ltd., has collaborated with John Fowler and Co. in the development of this form of hydraulic mechanical shunting locomotive.

Miscellanea

BRIT.I.R.E. HANDBOOK ON SOURCES OF TECHNICAL INFORMATION.—The British Institute of Radio Engineers has published a library handbook entitled "Library Services and Technical Information for the Radio and Electronics Engineer," which includes a catalogue of the contents of the Institution library, and contains up-to-date Institution reports on radio and electronic engineering literature and good engineering practice. Information is also given on international bodies, translating services, post-graduate fellowships and awards, and technical films on radio and electronics, provide a most useful section. Copies of "Library Services and Technical Information for the Radio and Electronics Engineer," (seventy-two pages, stiff card cover) may be obtained from the Institution, 9, Bedford Square, London, W.C.1, price 2s. 6d.

INSTITUTION OF PRODUCTION ENGINEERS.—The annual dinner of the Institution of Production Engineers was held in London on Wednesday, October 29. In welcoming the guests the president of the Institution, Lord Halsbury, spoke of the work of the Institution and said that the problem now facing British industry was to raise the standard of the average factory to that of the best. He pointed out that often the advantages gained by efficient production techniques in the machine shop were lost by high costs in assembly shops and production engineers should turn their attention to this fact. On the development of new machines and techniques, Lord Halsbury said that greater initial encouragement should be given to designers by purchasing and using firms who should take promising designs in the prototype form when they were available and prove their worth in practical application. In replying to this toast Sir William Black, chairman of the National Research Development Corporation, spoke of the financial assistance the corporation made available to help the development of inventions. He said that production engineers should pay greater attention to the fact that tooling up was now a major cost factor in industry, and if pre-production costs continued to increase it would be dangerous to industrial economy.

INSTITUTE OF WELDING.—Some 500 members and guests attended the annual dinner of the Institute of Welding, which was held in London on Wednesday, November 5. The toast of "The Institute" was proposed by Mr. W. J. Taylor, the Parliamentary Private Secretary to the Minister of Supply, who said that this country would have to extend its educational facilities for technical and scientific personnel if it was to meet the needs of modern industry. Since the late war great industrial progress had been made by this country and, said Mr. Taylor, it was the duty of everyone to further the overall interests of industry in general. In replying to the toast, the president of the Institute, Mr. J. Strong, spoke of the training work for which the Institute was responsible, and he pointed out that in the welding industry it was a continual struggle to keep abreast of the new materials becoming available and the requirements of those connected with scientific development.

LUBRICATION OF COMPRESSORS AND VACUUM PUMPS.—We have received from the Shell Petroleum Company, Ltd., a copy of a book entitled *Compressors and Vacuum Pumps and Their Lubrication*, which is the latest addition to the large range of useful reference books issued by that company. This 225-page publication first gives a general introduction to the subject of gases and liquids and comprehensive notes on the principles of lubrication. It then goes on to deal in detail with the construction of various types of machines—including reciprocating, rotary displacement and aerodynamic compressors, and high vaucum equipment. In each case, the application of lubricants and the lubricants required are given and a number of clear drawings showing the general construction of machines indicate in colour the parts or points at which correct lubrication is essential. Copies of the book are obtainable from Shell-Mex and B.P., Ltd., Shell-Mex House, Strand, London, W.C.2.

INTERNATIONAL CONVENTION ON TRANSISTORS, MAY 21–27, 1959.—The Institution of Electrical Engineers has found it necessary to bring forward the dates of the International Convention on Transistors and associated semi-conductor devices. The new dates are May 21–27, 1959. The change is concerned with the availability of accommodation at Earls Court, where the Convention is to be held. Associated with the Convention will be an international technical exhibition covering the manufacturing, application, research, development and other aspects of transistors and associated semi-conductor devices. This exhibition, which will remain open during the period of the Convention, will also be held at Earls Court. Anyone wishing to attend the Convention should apply to the Secretary, The Institution of Electrical Engineers, Savoy Place, London, W.C.2 (Temple Bar 7676). Inquiries about exhibition space should be made to Industrial and Trade Fairs, Ltd., Drury House, Russell Street, London, W.C.2 (Temple Bar 3422) the organiser of the exhibition on behalf of the Institution.

LECTURES ON MOTORWAYS.—The Pavings Development Group, Terminal House, Grosvenor Gardens, London, S.W.1, has arranged lectures by two distinguished engineers at the Institution of Civil Engineers, Great George Street, London, S.W.1, on Thursday, November 20, 1958. The first of them entitled "The development of urban motorways in Brussels," will be given by Monsieur André Saccasyn, Inspecteur Général des Ponts et Chaussées, Ministry of Public Works, Belgium. His talk will cover not only the recent road reconstruction in Brussels but also plans for future improvements to the road system. The second lecture will be given by Mr. J. W. Vickrey, Deputy Chief Highway Engineer to the State of California. Mr. Vickrey has been responsible for highway planning in California for the past eleven years, during which time California has made its most rapid progress in freeway planning and construction. The California Division of Highways is probably the largest organisation of its type in the world to-day, and is building highways at a rate of approximately 2,000,000 dollars per working day. Mr. Vickrey's lecture, "Development and planning of road systems in California," will cover all aspects of this development and will pay particular attention to the problem of traffic in metropolitan areas.

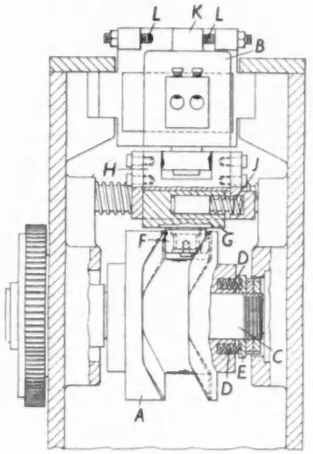
British Patent Specifications

When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification. Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 3s. 6d. each.

MACHINE TOOLS

803,124. April 13, 1956.—HEADING MACHINES, George H. Alexander Machinery, Ltd., Waddams Pool Works, Dudley, Worcestershire. (*Inventor: Frank Wright.*)

The invention relates to improvements in or modifications of so-called heading machines described in Specification No. 759,096 and used for forming heads on lengths of steel or other wire in the manufacture of small screws, rivets, &c. The particular object of the invention is to provide in such a machine convenient means for ensuring accurate location of the tools relative to the die. The drawing shows



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a sectional front view of a machine similar to that described and illustrated in Patent No. 759,096 with the following modifications. The rotary cam *A* for actuating the heading-tool carrier *B* is keyed to its shaft *C* but is axially slidable on it in one direction against the action of a spring or springs *D* between the cam and an abutment *E* fixed on the shaft. Also the throw of the cam *A* is arranged to be greater than that required to move the heading-tools alternately into alignment with the die. Further the roller *F* which engages the cam *A* is mounted on a stub axle projecting from a slide *G* carried by the actuator *H*, this slide being movable relative to the actuator in one direction against the spring *J*. The heading-tool carrier *B* is provided with a projection *K* which co-operates with adjustable stops *L*. These stops are each adjusted so as to arrest the movement of the tool-carrier when one of the tools respectively is correctly aligned with the die, and the arrangement is such that when the cam *A* moves the tool-carrier into contact with the one stop the excess stroke of the cam is absorbed in the compression of the spring *J* acting on the slide *G* of the actuator. When the carrier is moved into contact with the other stop the excess stroke of the cam is absorbed by axial movement of the cam *A* on its shaft to compress the spring *D*. Thus in both extreme positions of the tool-carrier it is resiliently held against the appropriate stop. By the invention, therefore, since the stops *L* can be adjusted accurately and the tool-carrier *B* is held resiliently in turn against each of the stops, accurate location of the tools is ensured even though lost motion may exist in the mechanism due to wear or other causes.—*October* 15, 1958.

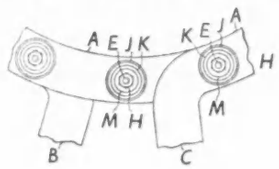
ELECTRICAL ENGINEERING

802,825. January 5, 1956.—LEAD ALLOYS FOR ACCUMULATOR BATTERIES, The Accumulatoren-Fabrik Aktiengesellschaft, Neue Mainzerstrasse 54, Frankfurt-am-Main, Germany. (*Inventors: Klaus Clostermann and Heinz Borchers*).

In the accumulator battery according to the invention a grid is made of a lead-antimony alloy having an antimony content between 2 and 20 per cent by weight and including an addition of arsenic between 0·075 and 0·1 per cent by weight and of copper between 0·04 and 0·12 per cent by weight. Microscopic tests show that with this alloy the lead-antimony eutectic is deeply penetrative and is incorporated into the basic lead mass in such a way as largely to prevent anodic corrosion in the accumulator cell or cells. Comparative tests have shown that the use of this alloy gives a cell grid a 75 per cent greater life than a known lead-antimony alloy having 8 per cent antimony, whereas an alloy having an appropriate arsenic addition, without copper, gives only a 47 per cent increase in life over such known alloy. It has also been shown that there is no advantage in increasing the antimony content in this alloy above 8 per cent, but that it is preferable for such content not to be reduced below 5 per cent. No disadvantageous effect on the negative grids due to the inclusion of copper in the positive grid alloy has been observed in the tests, and further tests on the positive grid and on the electrolyte have shown that the copper remains in the positive grid. Although the alloy including arsenic and copper may also be used for the negative grid or grids, it is preferable to use it only for the positive grids.—*October* 15, 1958.

802,856. February 15, 1957.—HIGH CAPACITY CHOKE FOR D.C. INSTALLATIONS, Maschinenfabrik Oerlikon, Zürich-Oerlikon, Switzerland.

The invention relates to a choke of high current-carrying capacity for d.c. installations comprising several tie-bolts passed axially through a coil. It is characterised in that the coil consists of a number of consecutive, axially adjacent turns, separated by intervening insulating layers, of an edgewise-wound flat conductor, pierced by holes through which the tie-bolts are passed. By thus compressing the turns of a flat conductor by means of tie-bolts which pass through the actual material of the conductor, a rigid hollow cylindrical coil of exceptionally high mechanical strength is produced, a factor of great importance in high-capacity chokes which are subject to considerable mechanical loads in d.c. installations where they are used to equalise and smooth the current and to limit the rise in the current when a short-circuit occurs. These loads are due, on the one hand, to the very high short-circuiting currents that sometimes arise and, on the other hand, to the continuously pulsating magnetic forces set up by harmonics. As shown in the drawing the coil is formed from a flat,



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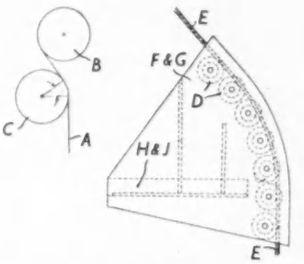
edgewise-wound, aluminium conductor *A* of which the ends *B* and *C* are joined to terminals (not shown). Equidistantly distributed around the circumference of the coil are holes *D* drilled through the centre of the conductor and tie-bolts *E*, enclosed in insulating bushings *F*, are passed through the holes. The individual turns of the conductor *A* are separated by insulating rings *G* and they are then compressed by nuts *H* through insulating discs *J*, compression plates *K*, compression springs *L*, compression discs *M*.—*October* 15, 1958.

MINING ENGINEERING

802,732. November 23, 1954.—ROPE GUIDES FOR MINE HOIST INSTALLATIONS, The Gutehoffnungshütte Sterkrade Aktiengesellschaft, (22a) Oberhausen, Rhineland, Germany.

The invention relates to mine hoist installations having a winding engine in a tower, and it provides a rope guide for changing the direction of the hoisting rope. Referring to the drawings, the left-hand view is only intended to explain the manner in which the hoisting rope *A*, in a mine installation of the tower type, is passed around a driving pulley *B*, one of the two sides of the rope *A* extending downwardly from the pulley *B* being shown making contact along an arc of about 45 deg. with a direction-changing pulley *C* underneath but not vertically below *B*. In accordance with the invention, instead of the direction-changing pulley *C*, a guide for the hoisting rope is provided which, as shown in the right-hand view, consists of a number of guide rollers *D*, each of which rotates freely and has peripheral grooves for the hoisting rope *E*. The axles of the rollers *D* are mounted between two supports in the form of segmental plates *F* and *G*. The plates are fixed by means of suitable members, e.g. angles *H* and *J*, to a point of the tower underneath the driving pulley, such as the pulley *B*, in such a position that the rope guide formed by the rollers *D* will produce the required change of direction of the rope *E* as it passes from the driving pulley *B*. The rollers are located in close proximity to one another with their axes spaced on a curve so that they form a curved guide path for the rope *E*, having a length corresponding to that of the arc of contact which the rope would make with the pulley *C*. The diameter of the rollers *D* is kept as small as possible so



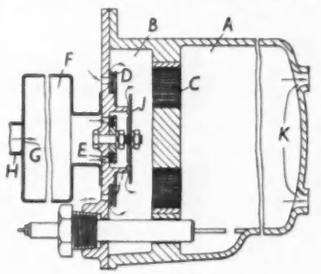
No. 802,732

as to enable the hoisting rope *E* to be supported at a sufficient number of places along the guide path in the region where the direction of the rope is changed. The rope guide, as described, has the advantage that the manufacture of the rollers forming the curved guide path is comparatively simple and cheap, the rollers can easily be provided with a lining to protect the rope and they can be exchanged separately. Also the moment of inertia of the rollers is very much smaller than that of the usual large direction-changing pulley, so that there is a saving of power during the starting up period of the hoist.—*October* 8, 1958.

FURNACE EQUIPMENT

802,927. February 20, 1956.—GASEOUS FUEL COMBUSTION APPARATUS, Joseph Lucas (Industries), Ltd., Great King Street, Birmingham, 19. (*Inventors: John Alfred Kitchen and Frederick Ronald Denham.*)

The invention relates to a gaseous fuel combustion apparatus of the so-called pulsating type, in which the inflow of fuel and air is controlled by valves responsive to intermittent pressure pulses in the combustion chamber. Its object is to provide an



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apparatus in which the fuel-air mixture is prepared before admission to the combustion chamber. As illustrated by the drawing there is provided a combustion chamber *A* of cylindrical form. At one end this chamber is extended to form a mixing chamber *B*, the two chambers being separated by a partition adapted to form a flame trap *C*, preferably constructed from a spirally coiled metal strip, the convolutions of which are separated by corrugations on the strip. On an end wall of the mixing chamber are mounted an air valve *D* for controlling the inflow of combustion air from the outer atmosphere, and a fuel gas valve *E*. Also on the end wall of the mixing chamber carrying the valves is secured a fuel gas cushioning chamber *F*. Gas is admitted to the chamber through a restricted orifice *G* from a supply pipe *H*. Further, there is preferably provided in the mixing chamber at the delivery side of the gas valve *E* a plate *J* which, together with an annular part in the chamber forms an orifice for deflecting the gas into the incoming air. When the apparatus is in action the air entering the mixing chamber meets the radially flowing stream of fuel gas and forms a combustible mixture. From the mixing chamber the mixture passes through the flame trap to the combustion chamber, where it is ignited, spreading of the resultant flame to the mixing chamber being prevented by the trap. In other respects the mode of action is essentially similar to other forms of apparatus of the pulsating kind, the valves being intermittently closed by the pressure pulses generated in the combustion chamber, and the combustion products being discharged through one or more outlets as *L* to apparatus to be heated.—*October* 15, 1958.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS

Tues., Nov. 18.—LONDON NATIONAL LECTURE: Magnet House, Kingsway, London, W.C.2, "Some Aspects of Railway Electrification," R. Ledger, 6.30 p.m. ★ ALDERSHOT AND DISTRICTS BRANCH: Red Cross Hall, High Street, Aldershot, "Power Transformers," P. G. Sanderson, 7.30 p.m. ★ EAST KENT BRANCH: Clarendon Hotel, Broadstairs, "Sound Production," F. H. Brittain, 8 p.m. ★ OXFORD AND DISTRICT BRANCH: Employment Exchange, Oxford, "The I.E.E. Regulations and the National Inspection Council," J. Looker, 7.30 p.m.

Wed., Nov. 19.—NOTTINGHAM BRANCH: Mechanic's Institute, Trinity Square, Nottingham, "The Electricity Regulations," S. J. Emerson, 7.30 p.m. ★ SOUTHAMPTON BRANCH: Pilgrim Room, Polygon Hotel, Southampton, Joint Lecture with the Electrical Contractors Association, 8 p.m. ★ WOLVERHAMPTON AND DISTRICT BRANCH: Chamber of Commerce, District Bank Chambers, Lichfield Street, Wolverhampton, "Industrial and Commercial Radio Communications," W. J. Anderson, 7.45 p.m.

Fri., Nov. 21.—MANCHESTER BRANCH: Engineers' Club, Albert Square, Manchester, "The Development of Television," R. T. B. Winn, 7 p.m.

BRITISH INSTITUTION OF RADIO ENGINEERS

Thurs., Nov. 20.—SCOTTISH SECTION: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, "An Electronic Engine Indicator," G. F. Norman; "An Electronic Pin Hole Detector for Tin Plate Inspection," D. Goodwin, 7 p.m.

Fri., Nov. 21.—SCOTTISH SECTION: The University, Drummond Street, Edinburgh, Repeat of lectures by G. F. Norman and D. Goodwin, 7 p.m.

COMBUSTION ENGINERING ASSOCIATION

Wed., Nov. 19.—WESTERN REGION: Park Hotel, Cardiff, "Smoke Abatement," J. Lawrence, 11 a.m.; "Grit and Dust Collecting Equipment for the Smaller Plant," G. Oddy, 2.15 p.m.

DIESEL ENGINEERS AND USERS ASSOCIATION

Thurs., Nov. 20.—Institute of Marine Engineers, Memorial Building, 76, Mark Lane, London, E.C.3, "Notes on the Jerk System of Fuel Injection," W. A. Green and G. R. Green, 2.30 p.m.

ENGINEERING METROLOGY ASSOCIATION

Thurs., Nov. 20.—Northampton College of Advanced Technology St. John Street, London, E.C.1, "Tape Control of Motion," O. S. Puckle, 7 p.m.

INCORPORATED PLANT ENGINEERS

To-day, Nov. 14.—BIRMINGHAM BRANCH: Hotel Leofric, Coventry, "Maintenance of Automatic Plant," J. Ward, 7.30 p.m.

Wed., Nov. 19.—KENT BRANCH: Railway Hotel, Dartford, "Cathodic Protection," L. B. Hogben, 7 p.m.

Thurs., Nov. 20.—BLACKBURN BRANCH: White Bull Hotel, Blackburn, "The Application of Plant and Instrumentation to the Testing of Gas Turbine Combustion Chambers," A. E. Clarke, 7.30 p.m.

INSTITUTE OF BRITISH FOUNDRYMEN

Tues., Nov. 18.—EAST ANGLIAN SECTION: Public Library, Ipswich, "Automation in the Foundry," J. A. Hufton, 7.30 p.m.

Wed., Nov. 19.—LONDON BRANCH: Constitutional Club, Northumberland Avenue, London, W.C.2, "Precision Sand Casting," J. S. Turnbull, 7.30 p.m.

INSTITUTE OF NAVIGATION

Fri., Nov. 21.—Royal Geographical Society, 1, Kensington Gore, London, S.W.7, "Navigating Across the Antarctic," George Lowe, 5.15 p.m.

INSTITUTE OF PETROLEUM

Thurs., Nov. 20.—LONDON BRANCH: 61, New Cavendish Street, London, W.1, "Films in the Oil Industry," R. F. Leach, 6 p.m.

INSTITUTE OF ROAD TRANSPORT ENGINEERS

Mon., Nov. 17.—SCOTTISH CENTRE: North British Hotel, Princes Street, Edinburgh, "The Free Piston Gasifyer," F. J. Wallace, 7.30 p.m.

Tues., Nov. 18.—N.E. CENTRE: Three Tuns Hotel, Durham, "The Free Piston Gasifyer," F. J. Wallace, 7 p.m. N. REGIONAL CENTRE: Victoria and Station Hotel, Preston, "Is Lubrication Necessary?" R. C. Nicholls, 7.30 p.m. ★ W. REGIONAL CENTRE: Liverpool Architectural Society's Rooms, Bluecoat Chambers, School Lane, Liverpool, 1, "Unusual Types of Trailer and Air Suspension," T. A. S. Pollard, 7.30 p.m.

Thurs., Nov. 20.—METROPOLITAN AREA: Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2, "Taking Stock on Maintenance," P. H. Wyke Smith, 6.30 p.m. ★ YORKSHIRE CENTRE: Great Northern Hotel, Wellington Street, Leeds, 1, "The Design of Radial-Flow Turbo-Chargers and their Application to Road Transport and Public Service Vehicles," E. Kellett, 7.30 p.m.

INSTITUTION OF BRITISH AGRICULTURAL ENGINEERS

Mon., Nov. 17.—NORTHERN CENTRE: North Eastern Board's Lecture Theatre, Carliol House, Newcastle upon Tyne, "Soil Stabilisation Roads for Agricultural Use," F. W. Ingles, 6.45 p.m. ★ WESTERN CENTRE: Lockham School of Agriculture, Lacock, Wilts, "Aspects of Modern Lubrication for Agricultural Equipment," W. J. Nolan, 7.15 p.m.

Wed., Nov. 19.—E. MIDLANDS CENTRE: Nottinghamshire Farm Institute, Brackenhurst, Notts, One-Day Conference on "Cultivations and Seeding," 10 a.m.

INSTITUTION OF CHEMICAL ENGINEERS

Wed., Nov. 19.—MIDLANDS BRANCH: College of Technology, Gosta Green, Birmingham, "Chemical Engineering Aspects of Tar Acid Recovery," D. McNeil, 6.30 p.m.

INSTITUTION OF CIVIL ENGINEERS

Tues., Nov. 18.—Great George Street, Westminster, London, S.W.1, "Soil Engineering at Steep Rock Iron Mine, Ontario, Canada," R. F. Legget, 5.30 p.m.

Wed., Nov. 19.—N.W. ASSOCIATION: 9, The Temple, 24, Dale Street, Liverpool, Address by the Chairman, J. P. Bamber, 6.30 p.m.

Fri., Nov. 21.—MIDLANDS ASSOCIATION: Midland Institute, Paradise Street, Birmingham, 1, "Operational Experience at Calder Hall," K. L. Stretch, 6.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS

Mon., Nov. 17.—LONDON GRADUATE AND STUDENT SECTION: Savoy Place, London, W.C.2, Address by the President, S. E. Goodall, 6 p.m. ★ E. ANGLIA SUB-CENTRE: Technical College, Cambridge, "The ZETA Reactor," R. Carruthers, 6.30 p.m. ★ N.E. RADIO AND MEASUREMENT GROUP: King's College, Newcastle upon Tyne, "A New Cathode-Ray Tube for Monochrome and Colour Television," D. Gabor, P. R. Stuart and P. G. Kalman, 6.15 p.m.

Tues., Nov. 18.—MEASUREMENT AND CONTROL SECTION: Savoy Place, London, W.C.2, Discussion on "Ferro-Electrics," L. A. Thomas, 5.30 p.m. ★ N. MIDLAND UTILISATION GROUP: C.E.G.B. Offices, 1, Whitehall Road, Leeds, "Electrification of the U.K.A.E.A. Industrial Group Factories," J. W. Binns and W. J. Outram, 6.30 p.m. ★ N.W. MEASUREMENT AND CONTROL GROUP: Engineers' Club, Albert Square, Manchester, "Direct-Reading Iron-Loss Testing Equipment for Single Sheets, Single Strips and Test Squares," J. McFarlane, P. Milne and J. K. Darby, "The Control of Flux Waveforms in Iron Testing by the Application of Feedback Amplifier Techniques," J. McFarlane and M. J. Harris, 6.15 p.m.

Wed., Nov. 19.—RADIO AND TELECOMMUNICATION SECTION: Savoy Place, London, W.C.2, "Television Recording: A Survey of the Problems and the Methods Currently in Use," J. Redmond, 5.30 p.m. ★ SHEFFIELD SUB-CENTRE: Grand Hotel, Sheffield, "The Design and Performance of the Gas-Filled Cable System," E. P. G. Thornton and D. H. Booth, 6.30 p.m. ★ SOUTHERN CENTRE: S. E. B. Showrooms, 17, New Canal, Salisbury, "Colour Television," C. J. Stubbington, 6.30 p.m.

Thurs., Nov. 20.—EDUCATION DISCUSSION CIRCLE: Savoy Place, London, W.C.2, Discussion on "What is a Cultured Engineer," opened by K. R. Sturley, 6 p.m. ★ IRISH BRANCH: Trinity College, Dublin, "Space Heating by Electricity," P. Walsh, 6 p.m.

Fri., Nov. 21.—S. MIDLAND CENTRE: Midland Institute, Birmingham, "Operational Experience at Calder Hall," K. L. Stretch, 6.30 p.m. ★ N. STAFFORDSHIRE SUB-CENTRE: Technical College, Stoke-on-Trent, "Electrical Floor Warming," J. W. Moule and W. M. Stevenson, 7 p.m. ★ N.E. CENTRE: Technical College, Carlisle, "Some Aspects of Heat Pump Operation in Great Britain with particular reference to the Shinfield Installation," Miriam V. Griffith, 7 p.m.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND

Tues., Nov. 18.—39, Elmbank Crescent, Glasgow, "Modern Pumping Arrangements for Oil Tankers," E. H. W. Platt, 6.30 p.m.

INSTITUTION OF HIGHWAY ENGINEERS

To-day, Nov. 14.—LONDON BRANCH: Park Lane Hotel, Piccadilly, London, W.1, Annual General Meeting and Luncheon, 11.45 a.m.

Thurs., Nov. 20.—YORKSHIRE AND LINCOLNSHIRE BRANCH: The University, Leeds, "Highway Law," E. Gilbert Sharp, 7 p.m.

INSTITUTION OF MECHANICAL ENGINEERS

To-day, Nov. 14.—ORDINARY MEETING: 1, Birdcage Walk, Westminster, London, S.W.1, "Experimental Investigation into the Effects of Cross Flow with Condensation of Steam and Steam-Gas Mixtures on a Vertical Tube," T. Furman and H. Hampson, 6 p.m.

Mon., Nov. 17.—EASTERN BRANCH: Technical College, Collier Road, Cambridge, "ZETA Reactor," A. R. Carruthers, 6.30 p.m. ★ N.E. BRANCH: King's College, Newcastle upon Tyne, "The Bases of Measurement," H. Barrell, 6.30 p.m. ★ SCOTTISH A.D. CENTRE: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, C.2, "Inspection of Vehicles for Road Worthiness with special reference to Methods and Equipment," G. Grime and R. D. Lister, 7.30 p.m. ★ MIDLAND GRADUATES SECTION: Exchange and Engineering Centre, Stephenson Place, Birmingham, "Machinery Accidents and their Prevention," G. P. Brown, 7 p.m.

Tues., Nov. 18.—N.W. BRANCH LIVERPOOL PANEL: Liverpool Engineering Society, 24, Dale Street, Liverpool, "Failure of a 60MW Steam Turbine at Uskmouth Power Station," A. L. G. Lindley and F. H. S. Brown, 6 p.m.

Wed., Nov. 19.—APPLIED MECHANICS GROUP: 1, Birdcage Walk, Westminster, London, S.W.1, Discussion on "Working Stresses and Factors of Ignorance," 6 p.m. ★ SOUTHERN BRANCH: Technical College, Brighton, "Inspection of Road Vehicles," G. Grime and R. D. Lister, 6.30 p.m. ★ YORKSHIRE BRANCH: George Hotel, Huddersfield, "Quality in Engineering Manufacture," F. Nixon, 7 p.m. ★ N.E. A.D. CENTRE: The University, Leeds, "Investigation into the Mechanism of Oil Loss Past Pistons," P. de K. Dykes, 7.30 p.m.

Thurs., Nov. 20.—EASTERN BRANCH: College of Further Education, Luton, "Fatigue of Pressurized Fuselages," G. Norris, 7.30 p.m. ★ N. IRELAND BRANCH: Kensington Hotel, Belfast, "Recent Developments in Journal Bearing Design with Mention of Dry Bearings," R. J. Welsh, 7.30 p.m. ★ N.W. A.D. CENTRE: Crewe Arms Hotel, Crewe, "Fatigue Testing in Vehicle Components," T. C. F. Stott, 7.15 p.m. ★ E. GRADUATES' SECTION: College of Further Education, Park Square, Luton, "Fatigue of Pressurized Fuselages," G. Norris, 7.30 p.m. ★ E. MIDLANDS GRADUATES' SECTION: Ruston and Hornsby's Research Centre, Lincoln, "Modern Governors for Compression-Ignition Engines," R. A. Fuller, 7.15 p.m. ★ SOUTHERN GRADUATES' SECTION: Technical College, Southampton, "Diesel Engines for Small Cars," M. H. Howarth and C. J. Walder, 7.30 p.m. ★ YORKSHIRE GRADUATES' SECTION: The University, Leeds, Forum and Discussion on the Report on Practical Training, 6.30 p.m.

Fri., Nov. 21.—THOMAS HAWKSLEY LECTURE: 1, Birdcage Walk, Westminster, London, S.W.1, "Transmission of Acoustic Waves Through Structures," Leo L. Beranek, 6 p.m. ★ WESTERN GRADUATES' SECTION: Engineering Laboratories, The University, University Walk, Bristol, 8, "Small Centripetal Turbines for Aircraft Drives," M. J. Whitmarsh-Everiss, 7.15 p.m.

INSTITUTION OF PRODUCTION ENGINEERS

To-day, Nov. 14.—IPSWICH AND COLCHESTER SECTION: Golden Lion Hotel, Cornhill, Ipswich, "Joining Dissimilar Metals," A. A. Smith and J. G. Young, 7.30 p.m.

Mon., Nov. 17.—HALIFAX AND HUDDERSFIELD SECTION: Whiteley's Cafe, Westgate, Huddersfield, "Use of Radio Isotopes in Industry," D. B. Smith, 7.30 p.m. ★ SHEFFIELD SECTION: Grand Hotel, Sheffield, "Material Handling Group," H. Steel, 6.30 p.m. ★ COVENTRY SECTION: Craven Arms, High Street, Coventry, "Precision Grinding," C. L. David, 7.15 p.m. ★ NEWCASTLE UPON TYNE SECTION: No. 1 Chemistry Lecture Theatre, King's College, Newcastle upon Tyne, "The Bases of Measurement," H. Barrell, 7 p.m.

Tues., Nov. 18.—TEES-SIDE BRANCH: College of Further Education, Cleveland Avenue, Darlington, "Budgetary Control," D. R. Dolan, 7 p.m. ★ OXFORD SECTION: Town Hall, Oxford, "Motor Cars," J. F. Bramley, 7.30 p.m.

Wed., Nov. 19.—BIRMINGHAM SECTION: James Watt Memorial Institute, Great Charles Street, Birmingham, "The Cold Extrusion of Metals," R. Tilsley and J. Howard, 7.30 p.m. ★ WOLVERHAMPTON GRADUATE SECTION: Wolverhampton and Staffs College of Technology, Wulfruna Street, Wolverhampton, "Induction Heating and its Applications," D. G. Jones, 7 p.m. ★ PETERBOROUGH SECTION: Conference Room, Peterscourt, Peterborough, "Inspection Standards and Techniques," J. Loxham, 7.30 p.m. ★ WESTERN GRADUATE SECTION: Royal Hotel, College Green, Bristol, "Lubrication in all its Aspects," S. E. Holmes, 7.30 p.m.

Thurs., Nov. 20.—NORTHERN IRELAND BRANCH: Kensington Hotel, College Square East, Belfast, "The Practical Approach to Management Accounting," W. Murray, 7.30 p.m. ★ LONDON SECTION: Royal Empire Society, Northumberland Avenue, Strand, London, W.C.2, "Human and Organisation Problems in Inspection Departments," R. M. McKenzie, 7 p.m. ★ SOUTHAMPTON SECTION: Polygon Hotel, Southampton, "Plastics for Tooling," P. G. Pentz, 7.15 p.m. ★ GLASGOW BRANCH: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, C.2, "Quality in Engineering Manufacture," F. Nixon, 7.30 p.m.

Fri., Nov. 21.—DERBY SECTION: Louis Room, St. James's Restaurant, St. James's Street, Derby, "The Spacematic," W. J. Adams, 7 p.m.

INSTITUTION OF THE RUBBER INDUSTRY

To-day, Nov. 14.—MERSEYSIDE SECTION: Adelphi Hotel, Liverpool, Joint Meeting with the Plastics Institute, "Some Activities of the Scientific Department, National Coal Board, Including Underground Trials on Conveyor Belts," J. G. Norvall, and "Laboratory Tests on Conveyor Belts and Their Correlation with Trials' Results," D. Bulgin, 7.30 p.m.

INSTITUTION OF STRUCTURAL ENGINEERS

Wed., Nov. 19.—LANCASHIRE AND CHESHIRE BRANCH: College of Building, Liverpool, "Housing the Dounreay Fast Reactor," N. T. Barrett, 6.30 p.m.

Thurs., Nov. 20.—WESTERN COUNTIES BRANCH: University Engineering Laboratories, Bristol, Joint Meeting with the Institution of Civil Engineers, "The Strength of Lattice Girders," M. Holmes, 6 p.m.

JUNIOR INSTITUTION OF ENGINEERS

To-day, Nov. 14.—Pepys House, 14, Rochester Row, Westminster, London, S.W.1, Chairman's Address, "Development of the Iron and Steel Industry," P. Cameron, 7 p.m.

Fri., Nov. 21.—Pepys House, 14, Rochester Row, Westminster, London, S.W.1, "Printed Circuit Techniques," P. A. Trigg, 7 p.m.

MANCHESTER ASSOCIATION OF ENGINEERS

To-day, Nov. 14.—Engineers' Club, Albert Square, Manchester, "The Machining of Large Light Alloy Components by Computer Control," J. Gregson and A. Flett, 6.45 p.m.

NEWCOMEN SOCIETY

Wed., Nov. 19.—Lecture Theatre, Science Museum, South Kensington, London, S.W.7, "The Jones Falls Dam on the Rideau Canal, Ontario, Canada," R. F. Legget, 5.30 p.m.

NORTH EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS

To-day, Nov. 14.—Mining Institute, Neville Hall, Newcastle upon Tyne, "Notes on the Longitudinal Strength of Tankers," J. M. Murray, 6.15 p.m.

PLASTICS INSTITUTE

Tues., Nov. 18.—LONDON AND DISTRICT SECTION: Wellcome Building, 183-193, Euston Road, London, N.W.1, "Commercial and Cost Considerations in Injection Moulding," A. B. Merriam, 6.30 p.m.

Wed., Nov. 19.—NORTH-EASTERN SECTION: Eldon Grill, Grey Street, Newcastle, "Various Uses of Terylene Fibre," D. Seggie, 7 p.m.

Fri., Nov. 21.—MIDLANDS SECTION: James Watt Memorial Institute, Great Charles Street, Birmingham, "Plastics in the Building Industry," R. P. H. Gillett, 6.30 p.m.

REINFORCED CONCRETE ASSOCIATION

Tues., Nov. 18.—MIDLAND COUNTIES BRANCH: Birmingham and Midland Institute, Paradise Street, Birmingham, "The Architectural Expression of Structural Concrete," W. A. Gibbon, 6 p.m.

Wed., Nov. 19.—LONDON BRANCH: 11, Upper Belgrave Street, London, S.W.1, "Some Recent Developments in the Design of Reinforced Concrete Shell Roofs," J. D. Bennett, 6 p.m.

ROYAL SOCIETY OF ARTS

Wed., Nov. 19.—John Adam Street, Adelphi, London, W.C.2, Cadman Memorial Lecture, "Improving the Efficiency of the Mining Industry," L. A. Longden, 2.30 p.m.

ROYAL STATISTICAL SOCIETY

Wed., Nov. 19.—London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1, "The Long-Term Trend in the Size Distribution of Income," H. F. Lydall, 5.15 p.m.

SHEFFIELD SOCIETY OF ENGINEERS AND METALLURGISTS

Mon., Nov. 17.—The University Building, St. George's Square, Sheffield, "Progress in Rod and Bar Rolling," R. Stewartson, 7.30 p.m.

SOCIETY OF CHEMICAL INDUSTRY

Thurs., Nov. 20.—ROAD AND BUILDING MATERIALS GROUP: 14, Belgrave Square, London, S.W.1, "Scientific Investigation of Clay Pits," I. L. Freeman, 6 p.m.

SOCIETY OF INSTRUMENT TECHNOLOGY

Wed., Nov. 19.—Manson House, Portland Place, London, W.1, Symposium on "Analytical Instrumentation Developed at Harwell," 2.30 p.m. ★ NEWCASTLE SECTION: King's College, Stephenson Buildings, Newcastle on Tyne, "Flow Measurement with Particular Reference to the Dall Tube," D. H. Kent, 7 p.m.

Thurs., Nov. 20.—EAST MIDLAND SECTION: College of Further Education, Greenclose Lane, Loughborough, "Control of the Jodrell Bank Radio Telescope," P. J. Bhatt, 6.30 p.m.

UNIVERSITY OF NOTTINGHAM

Wed. and Thurs., Nov. 19 *and* 20.—Lecture Room, Portland Building, The University, Nottingham, Akroyd Stuart Memorial Lecture, 1958, "Pressure Waves in Gases in Pipes," F. K. Bannister, 9.30 a.m.

WEST OF SCOTLAND IRON AND STEEL INSTITUTE

To-day, Nov. 14.—39, Elmbank Crescent, Glasgow, "Slag Composition and Influence on Blast Furnace Practice," K. C. Sharp, 6.45 p.m.

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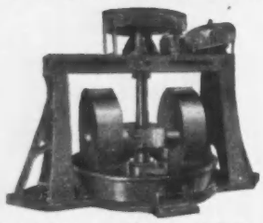

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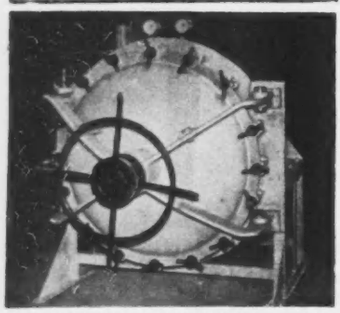

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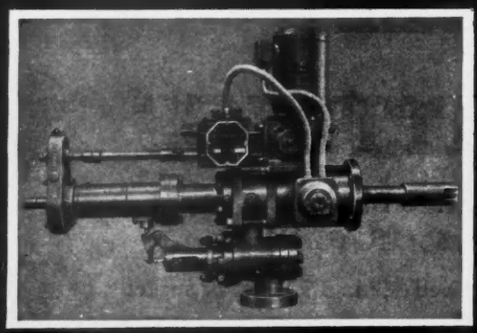

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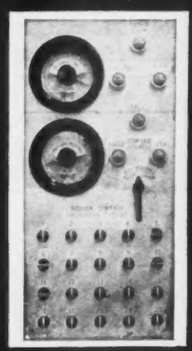

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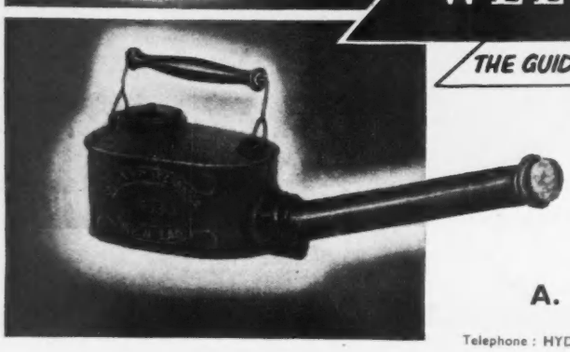

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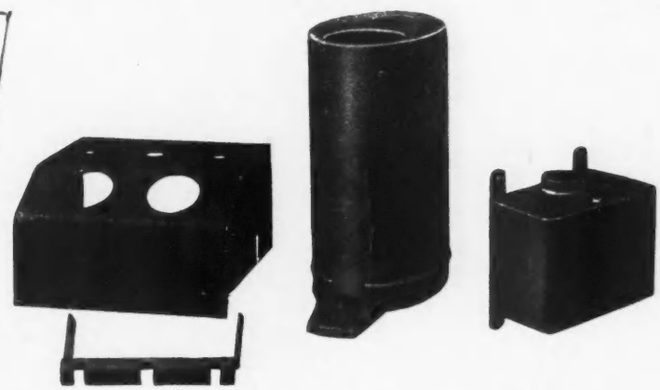

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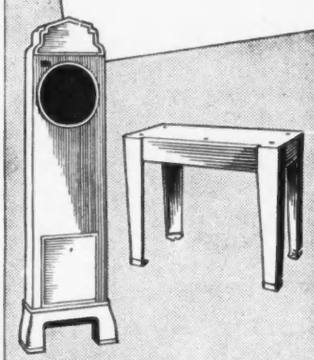

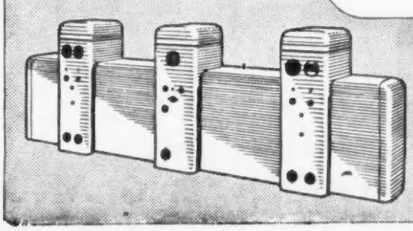

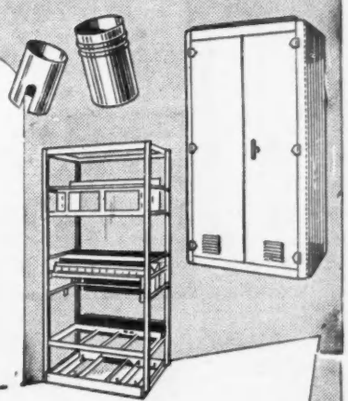

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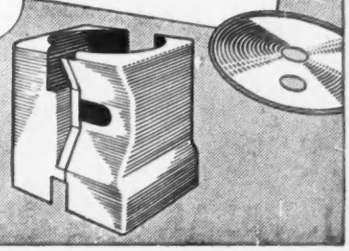

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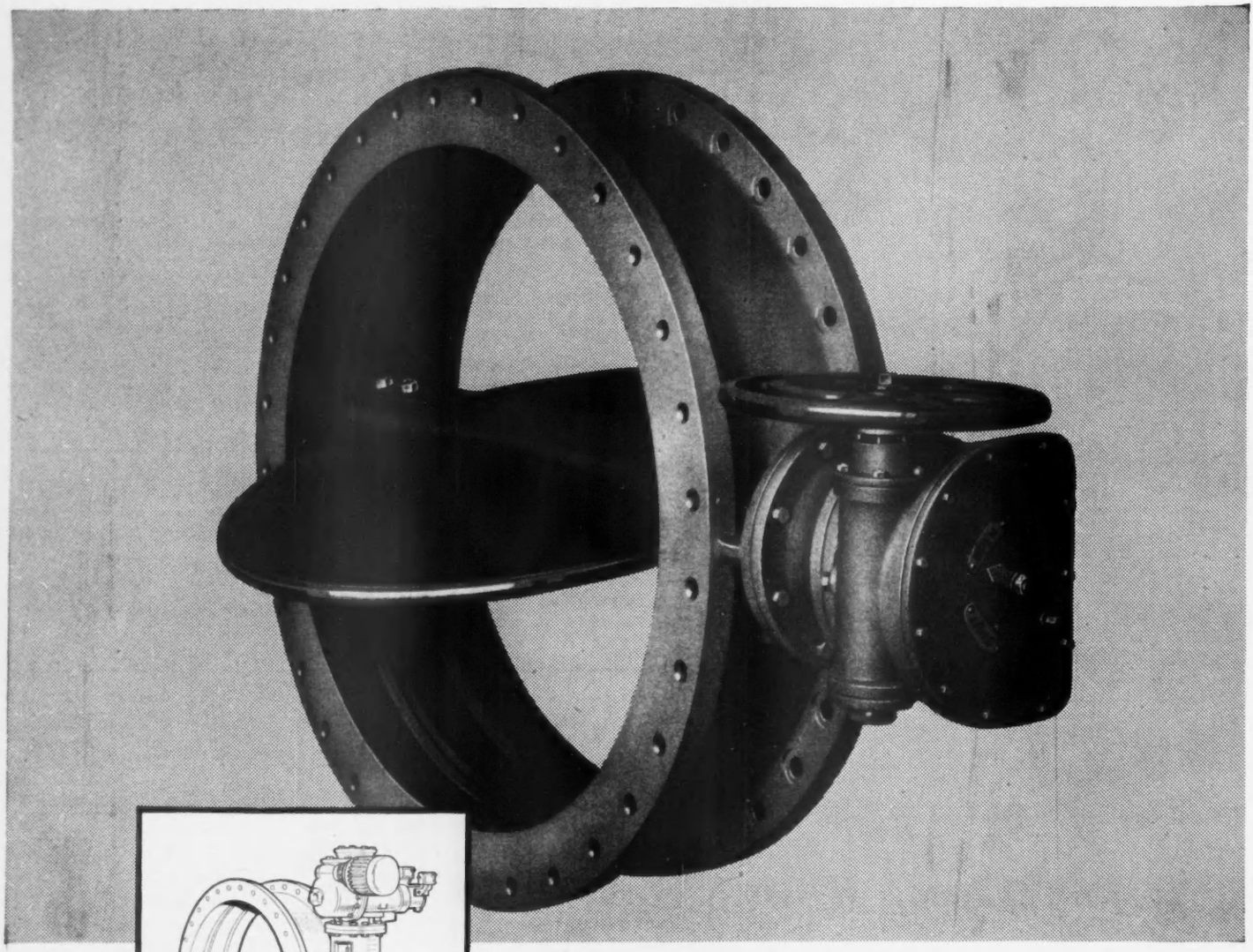

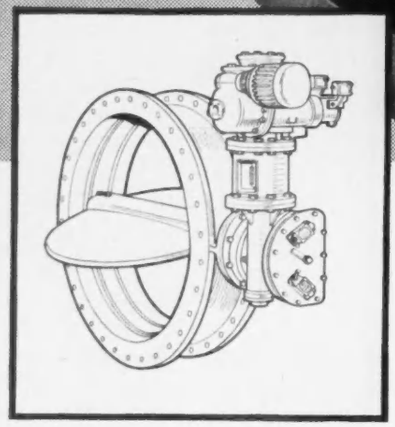

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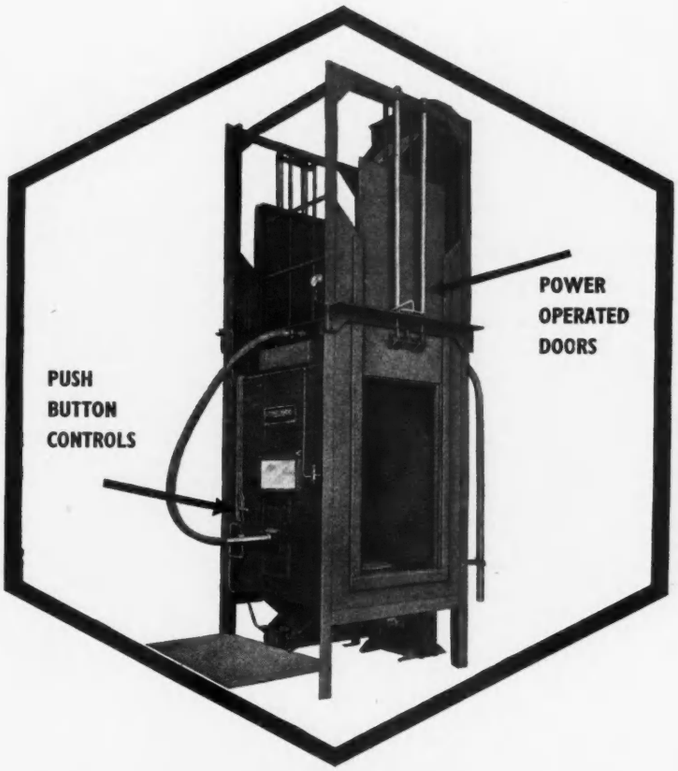

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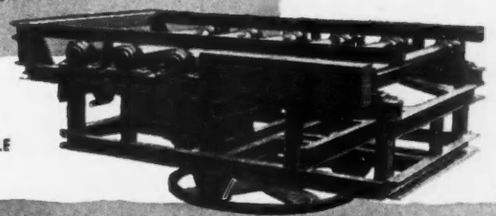

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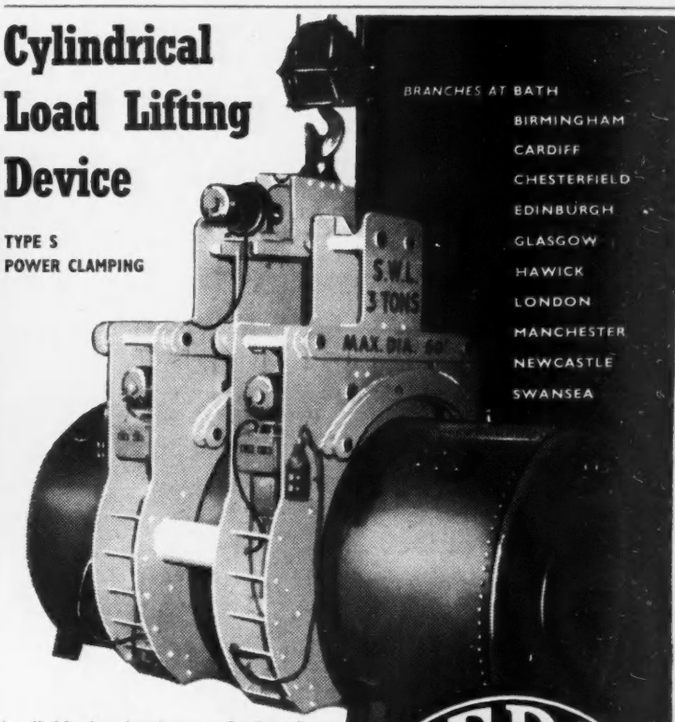

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How to select the right alloy

TO RESIST CORROSION

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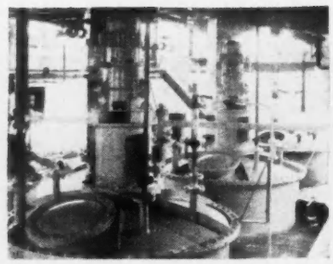
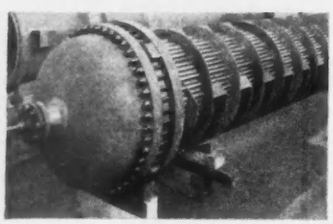


Chlorination vessels of Monel used in the production of selective weed killers. Fisons Pest Control Limited.

Atmospheric Corrosion: INDOORS most high-nickel alloys are immune. In industrial sulphurous atmospheres Inconel is superior. OUTDOORS the rate of attack is low. Inconel remains bright in most atmospheres. Even where Monel tarnishes, there is no destructive corrosion.

Fresh and Salt Water: When water high in salts and dissolved gases is handled, Inconel is the preferred material. In salt water, Monel is generally preferred in submerged exposure and Inconel in exposure to marine atmospheres. Monel is the ideal material for propeller shafts, fastenings, valves and pump parts handling salt water.



Heat exchanger for chemical processing with tubes of Low-Carbon A T Nickel welded to a nickel-clad steel tube plate. The dished head is also of nickel. Bertrams Limited.

Neutral and Alkaline Salts: Nickel resists this type of attack while Monel is widely used in salt processing. Inconel is especially suitable for equipment handling food and refrigerating brines since it resists pitting.

Acid Salts: Generally Monel is superior to nickel and Inconel with acid salts such as zinc chloride, ammonium sulphate and aluminium sulphate. Inconel is one of the few materials available for use in contact with hot, strong solutions of magnesium chloride and is superior for resisting oxidizing acid salts.

Oxidizing Alkaline Salts: Hypochlorites are the only common alkaline salts corrosive to Monel, nickel and Inconel.

Mineral Acids: Monel is among the few mechanically strong materials which resist corrosion by dilute hydrochloric and sulphuric acids. It is resistant to air-free hydrofluoric acids of all concentrations and at all temperatures including boiling. Monel is used in sulphonation, pickling and hydrofluoric acid alkylation. Nickel is useful in chlorination equipment.

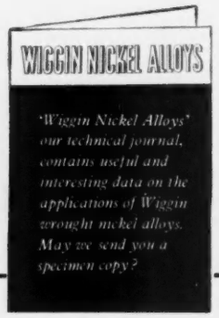
Oxidising Acids: Such as nitric in concentrations over 20 per cent have little corrosive attack on Inconel.

Organic Acids and Compounds: Inconel resists this type of attack so well that it is widely used in food processing and pharmaceutical manufacture. Nickel is frequently chosen for food processing equipment because of its ability to protect purity. Monel is useful in resisting corrosion in the manufacture of fatty acids.

Alkalies: Alkalies such as caustic soda have practically no corrosive effect on nickel. In less severe applications Monel is often used. Inconel is chosen where alkaline sulphur compounds are handled.

Wet and Dry Gases: At atmospheric temperatures no dry gas is actively corrosive to nickel or to Inconel. Nickel is one of the most useful materials for handling chlorine, fluorine and bromine at temperatures up to about 540°C. and is free from corrosion by steam up to 425°C. Inconel is used for handling steam up to about 800°C. Above this temperature one or other of the Nimonic Series of Alloys is generally used.

The choice of materials for corrosion-resistance is a job for the expert. Besides Monel, Inconel and nickel, other alloys such as "Corronel B" and "Ni-o-nel" have been developed for specific problems. Our Technical Service engineers are always ready to give advice on the detailed applications of wrought high-nickel alloys in the light of many years specialised experience.



"Wiggin Nickel Alloys" our technical journal, contains useful and interesting data on the applications of Wiggin wrought nickel alloys. May we send you a specimen copy?

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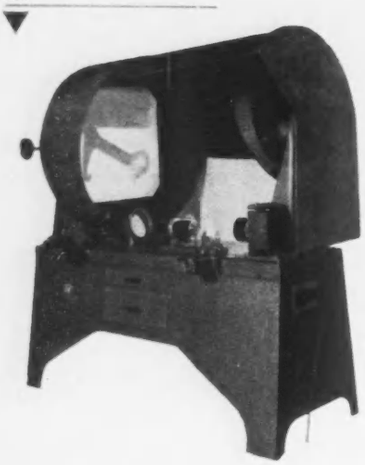

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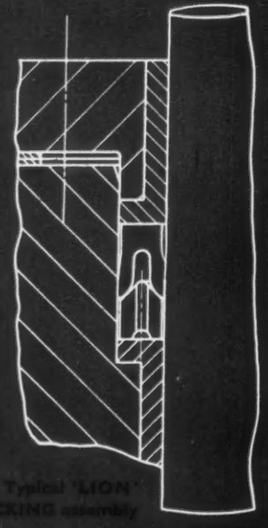

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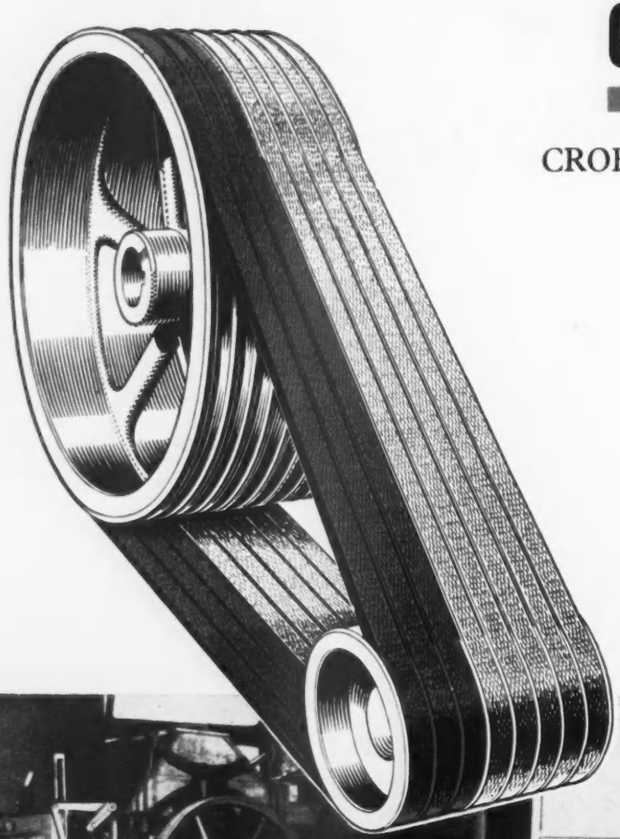

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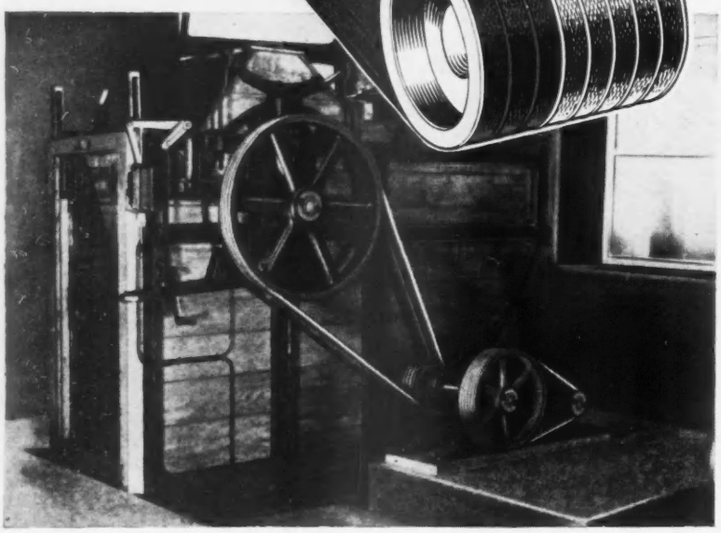

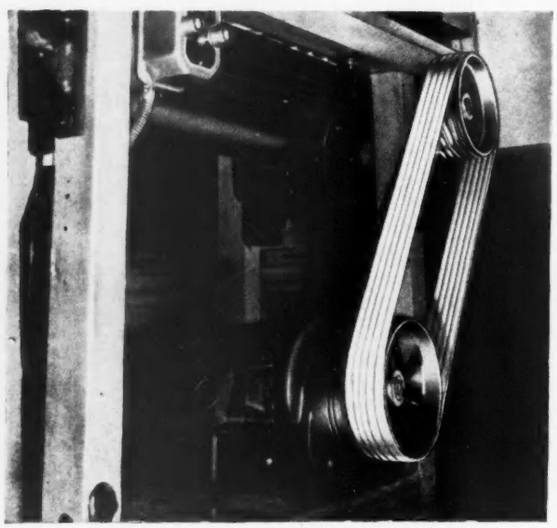

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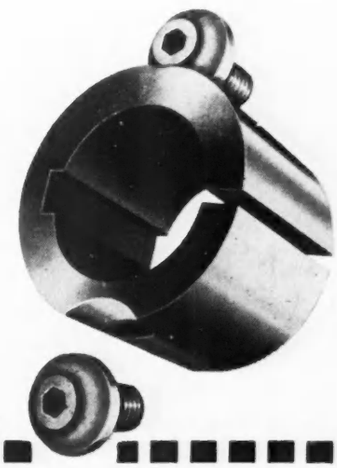

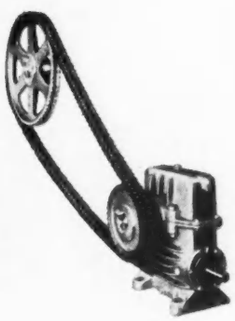

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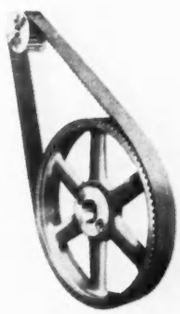

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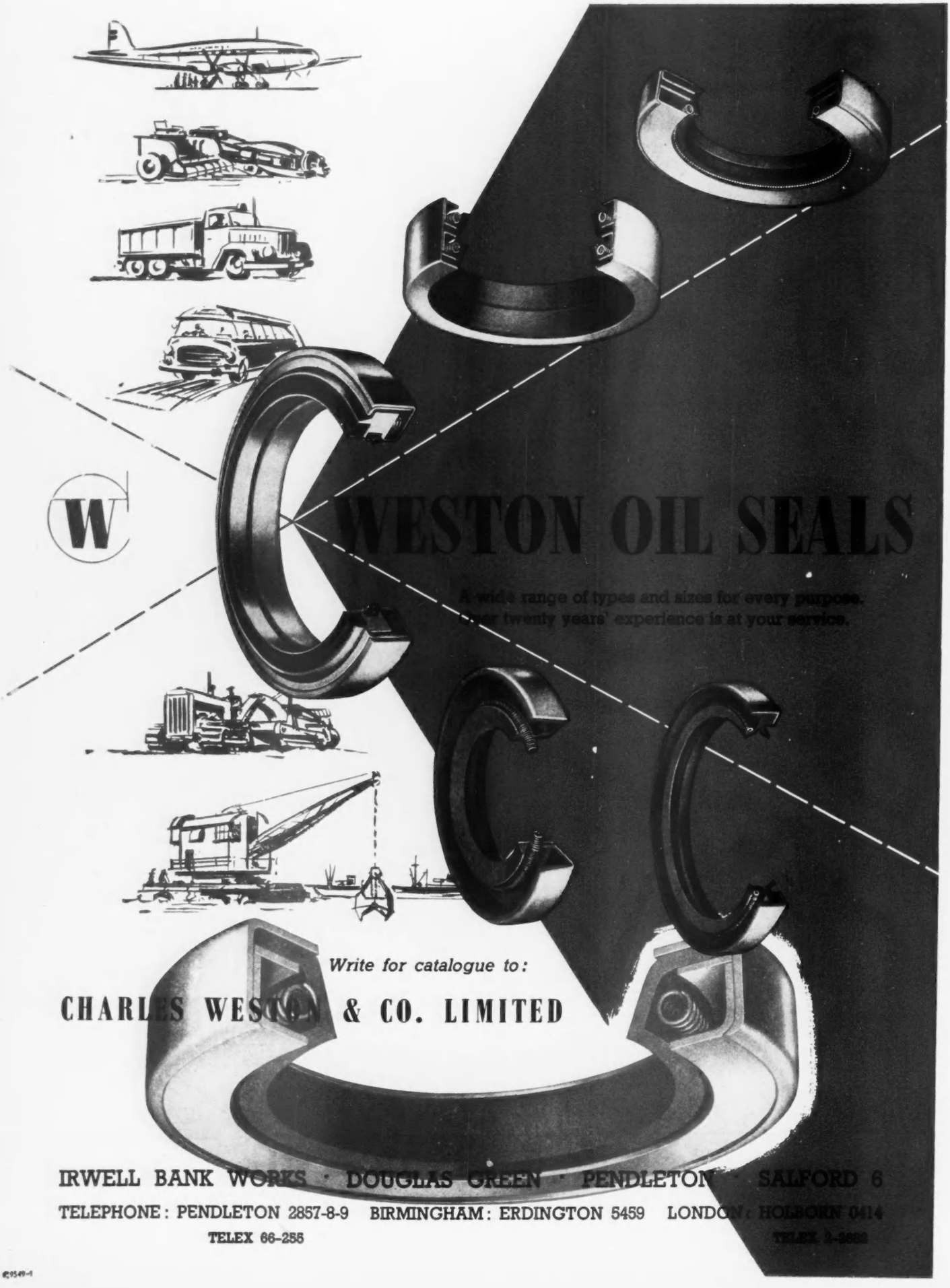
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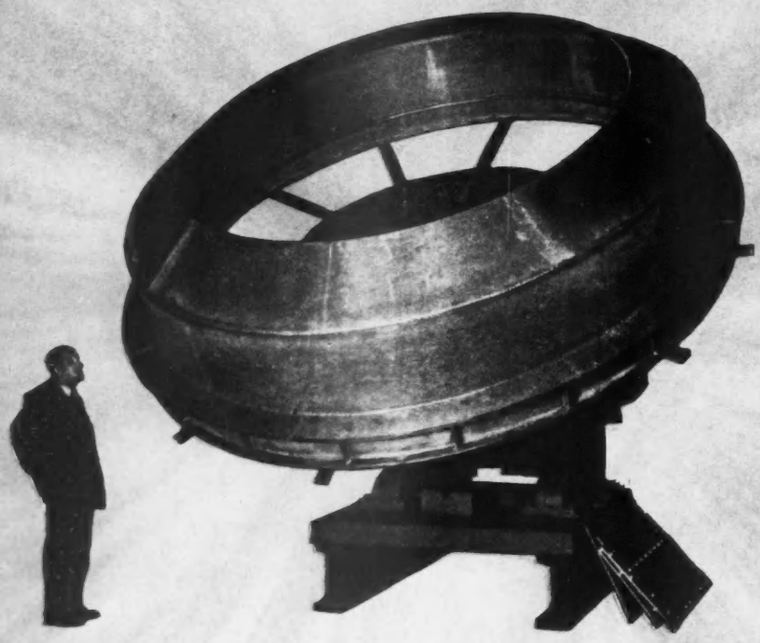

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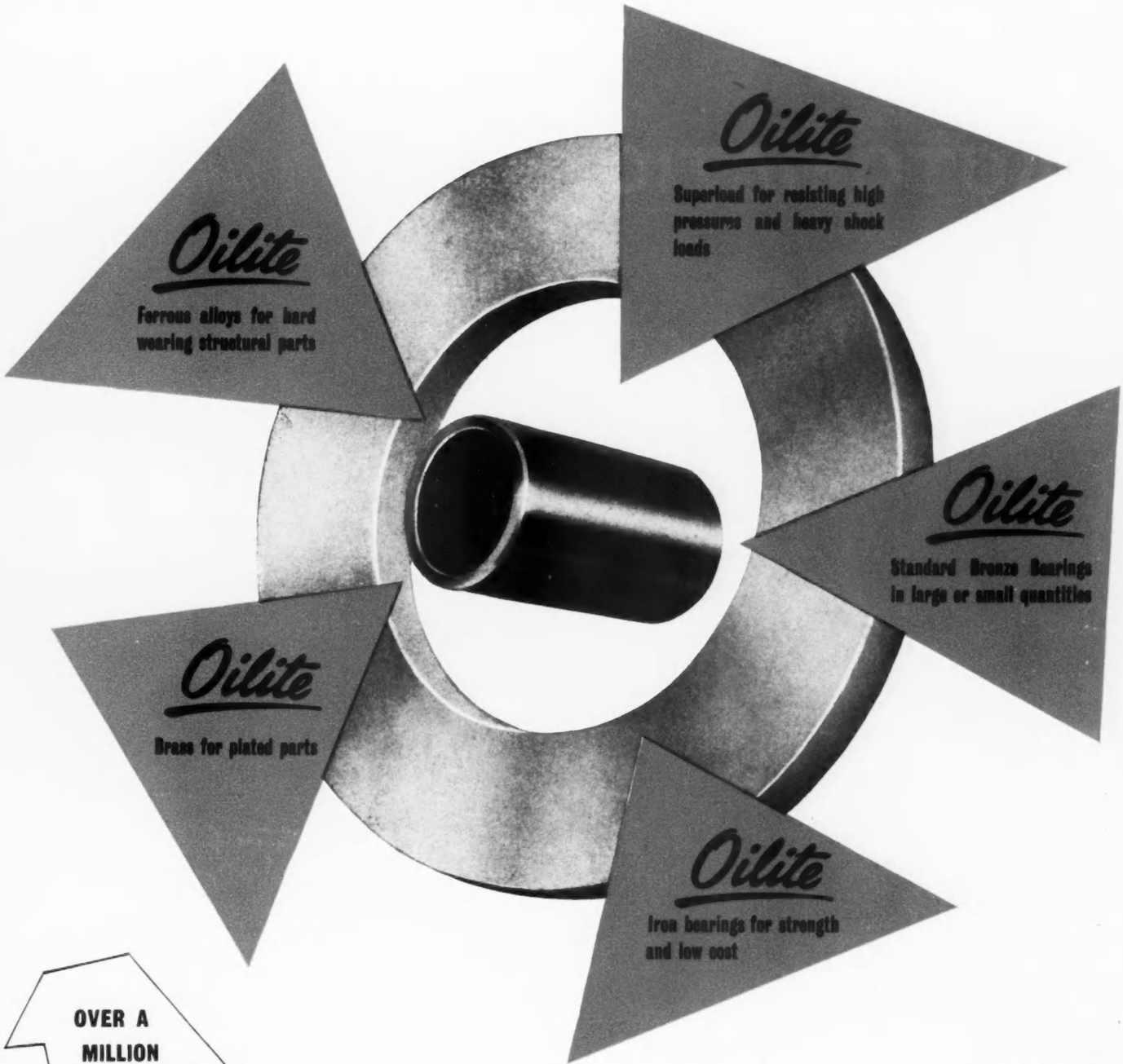
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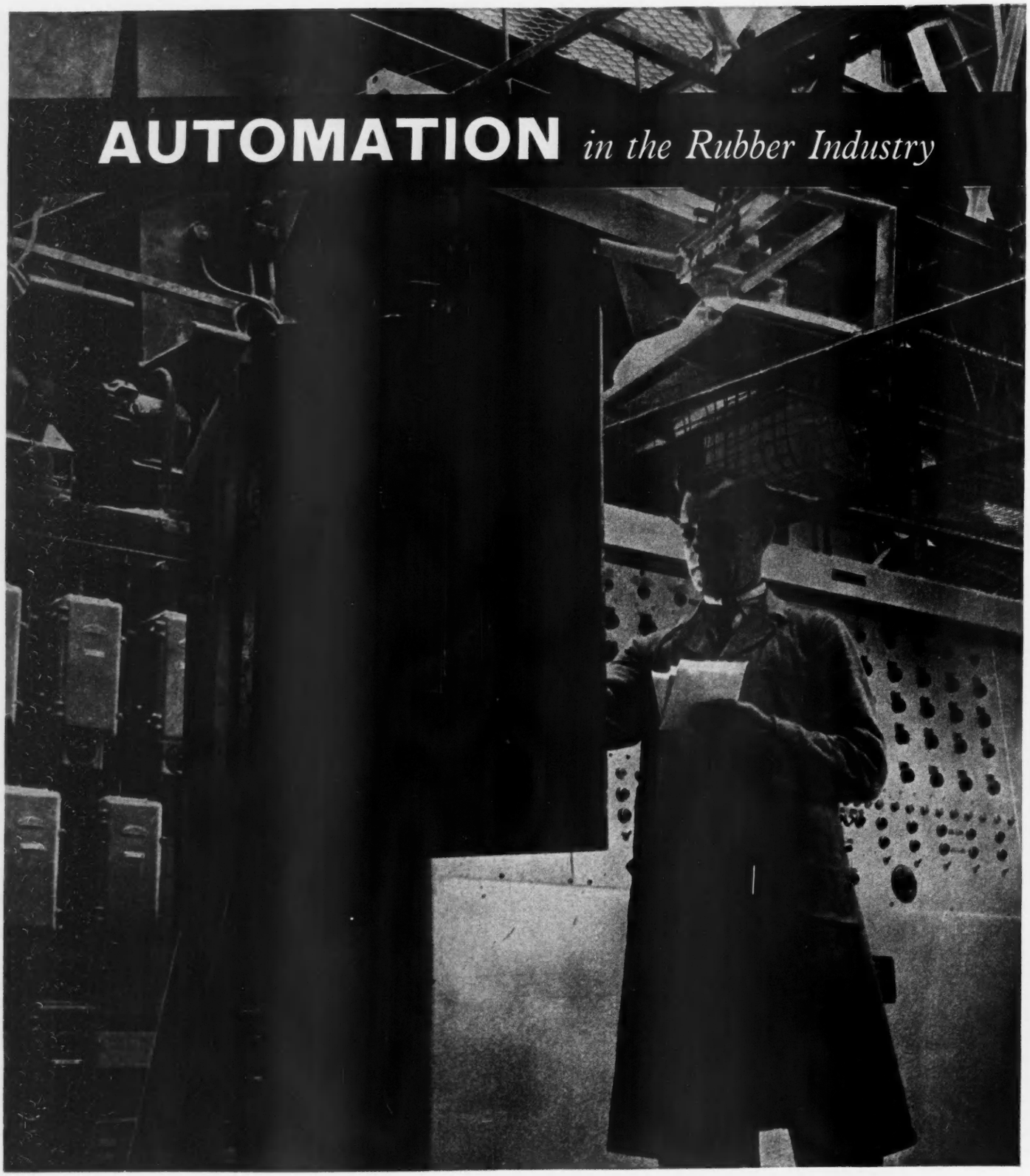

Setting up a formulation in an automatic plant for compounding rubber

Rigid specifications and the concise requirements demanded by modern industry, call in turn for great accuracy in the compounding of rubber mixes. Here the operator at the control panel of the first automatic rubber compounding plant in operation in the British Isles, is seen determining the necessary ingredients and quantities, so as to ensure this accuracy. Thereafter the various silos situated above automatically release the required amounts into hoppers which then move into the rubber mill.

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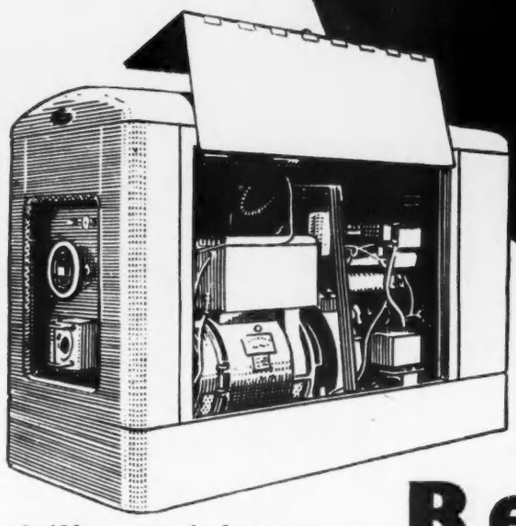

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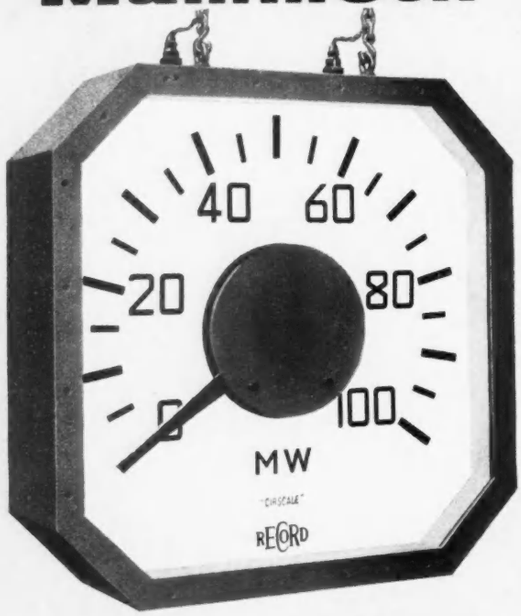

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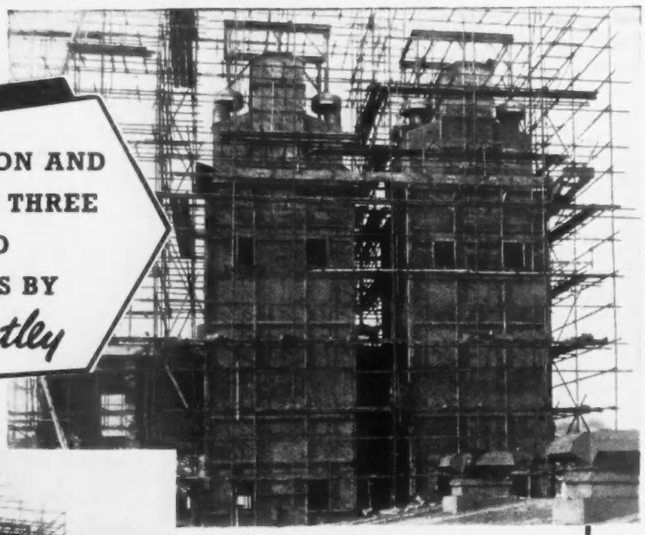

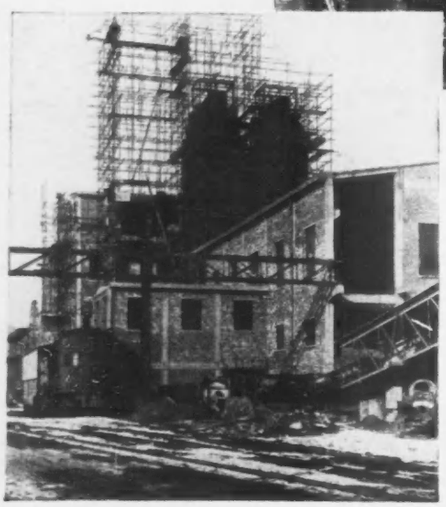

Above: A close-up view of the upper parts of the two Precipitators.

Left: The erection of two of the three Precipitators nearing completion. Their overall height from ground level is 92 feet and we erected scaffolding to a height of 120 feet for the job.

These photographs and details are published by courtesy of the National Coal Board, South-Western Division, and the Main Contractors, Messrs. Simon Carves Ltd., Precipitator Division, Cheadle Heath, Stockport.

the complete manufacture of the sections and component parts was undertaken at our works and erected on site by our own staff

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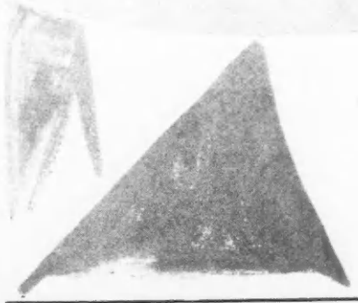

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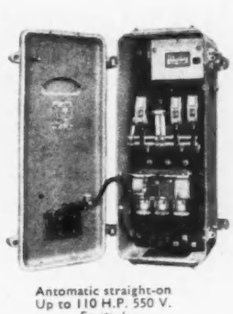

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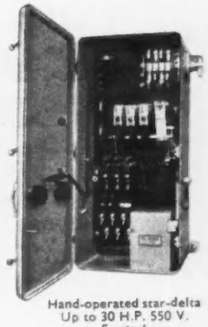

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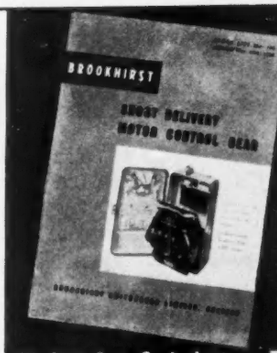

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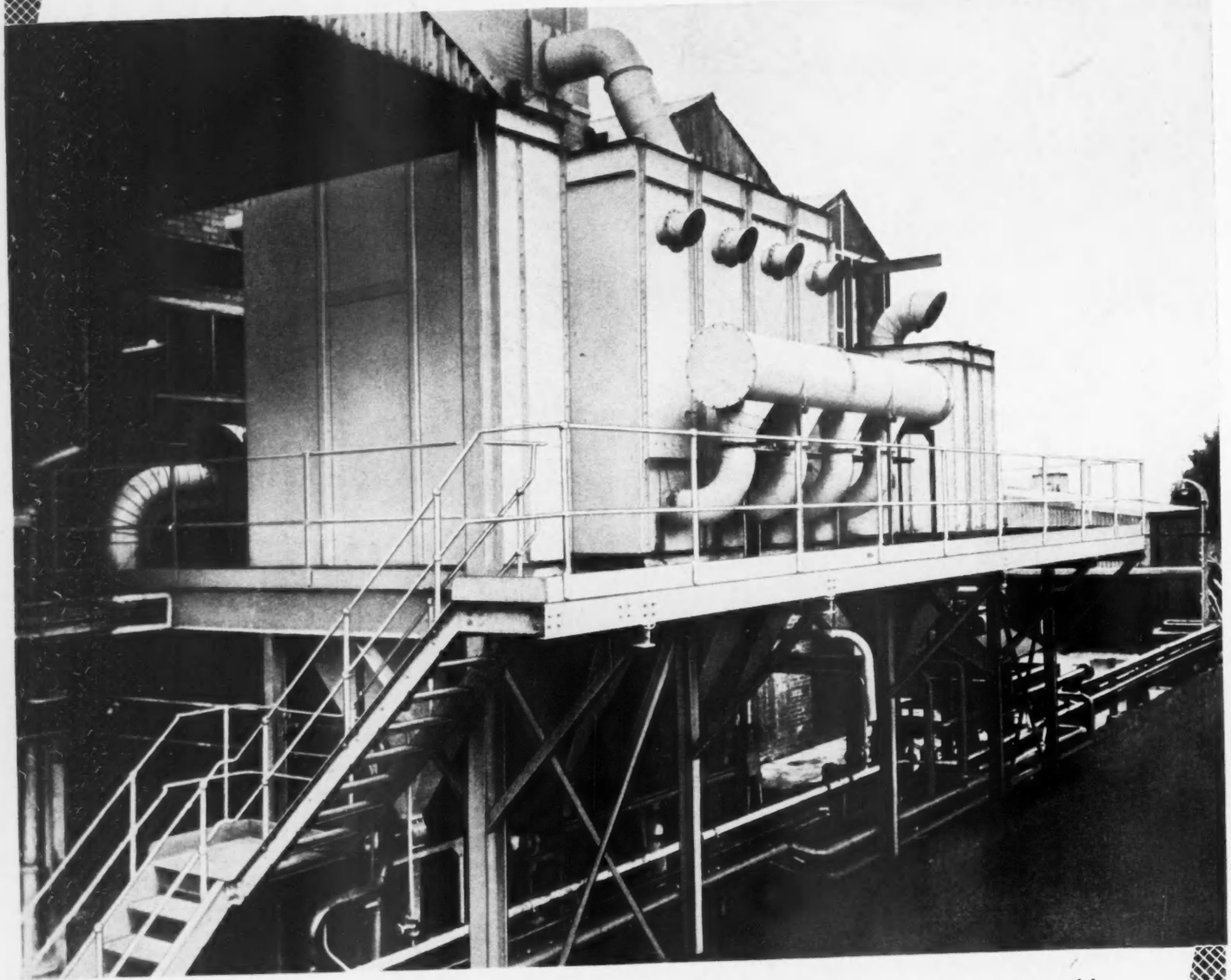

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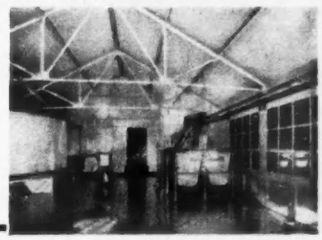

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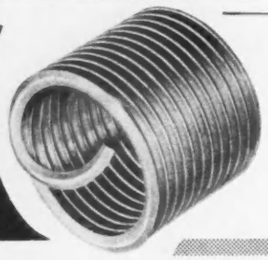

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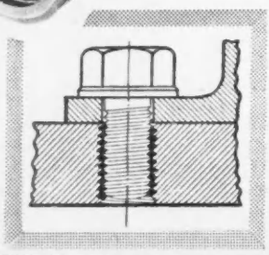

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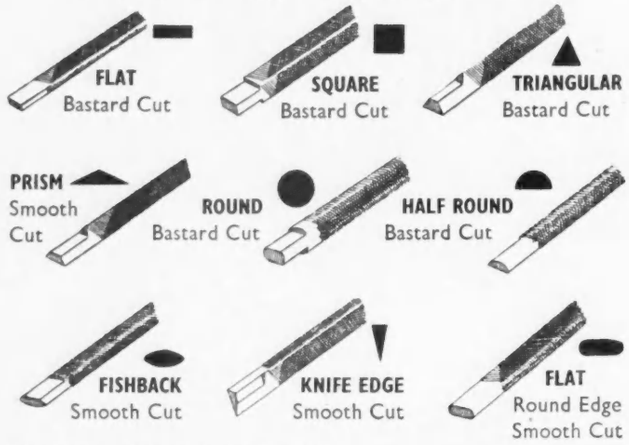

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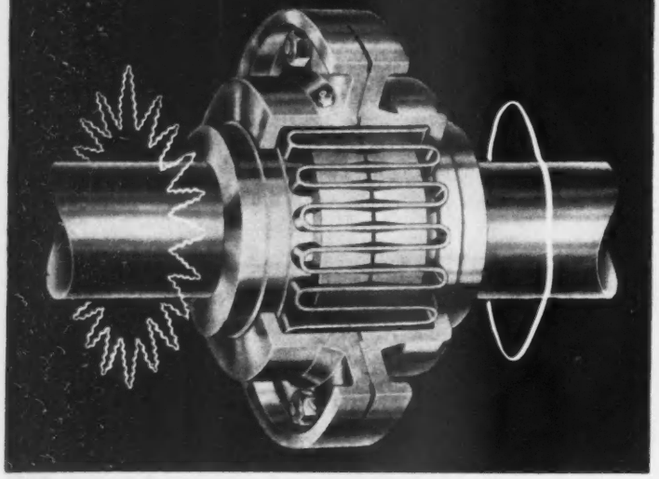

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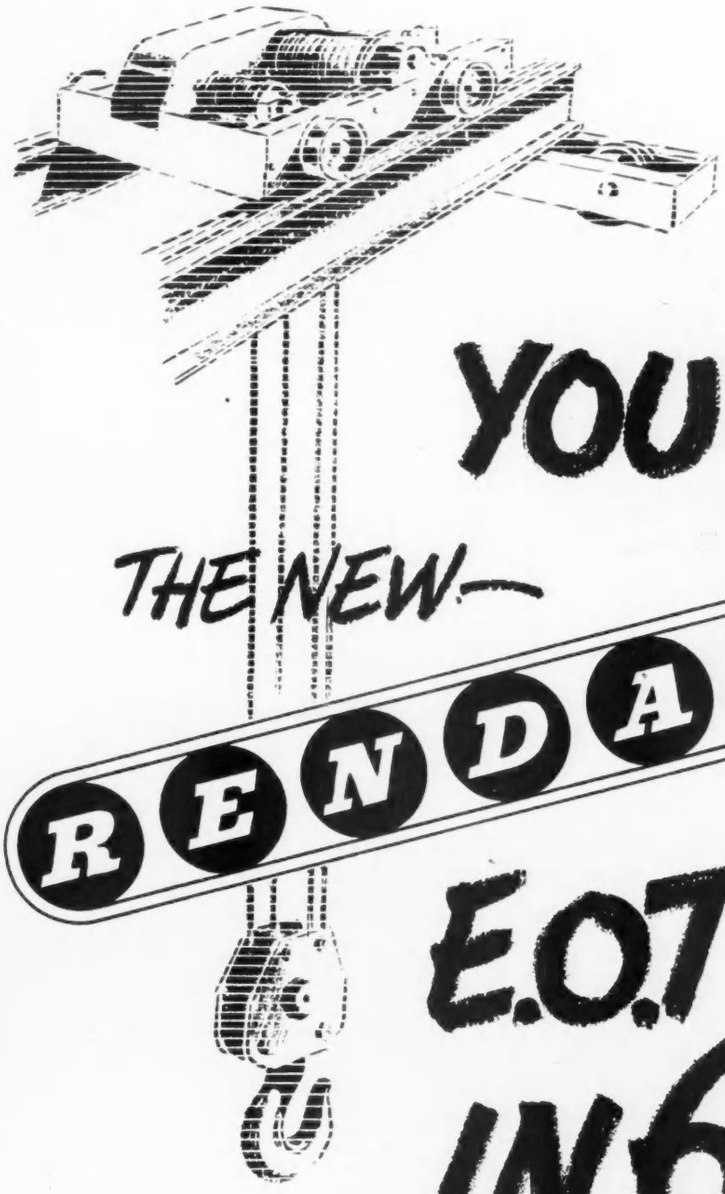

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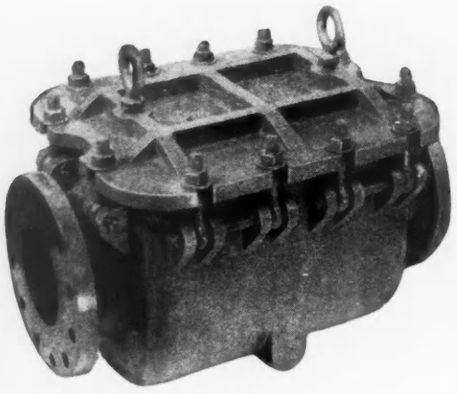

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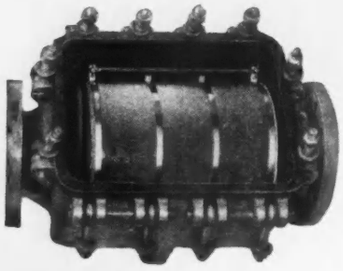

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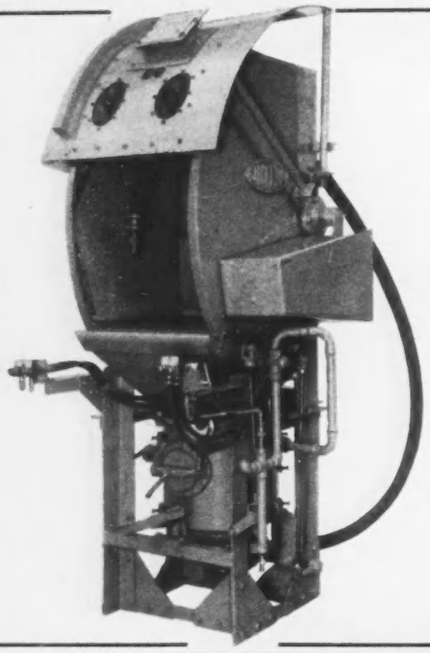

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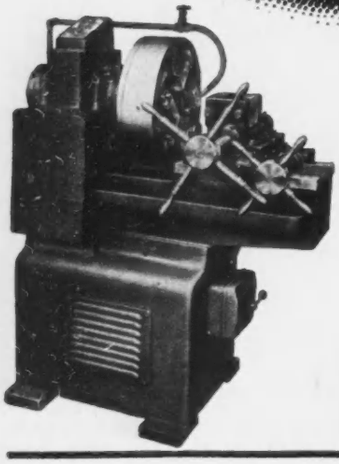

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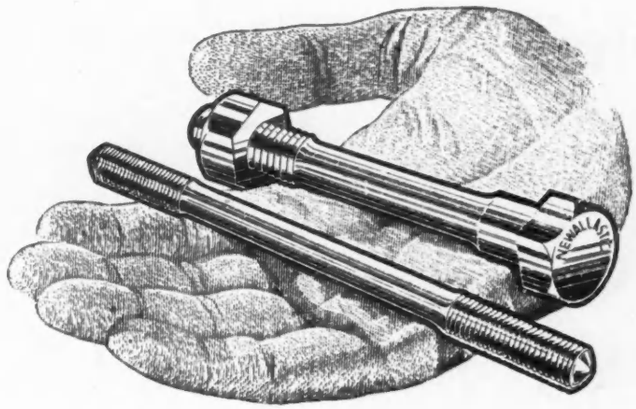

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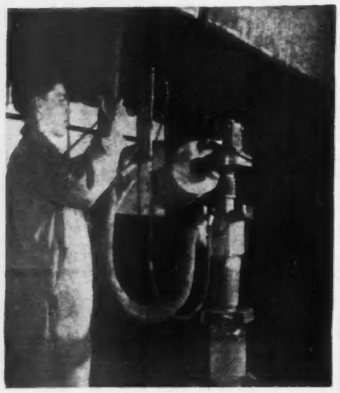

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Stage 3
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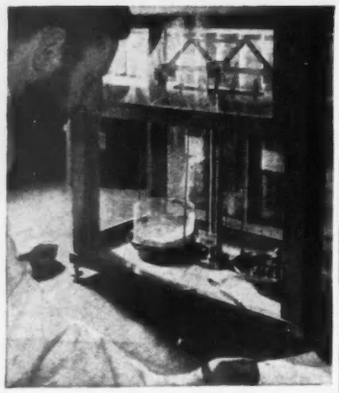

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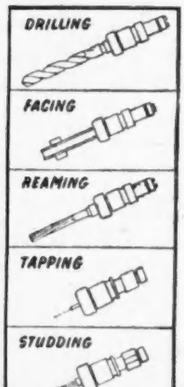

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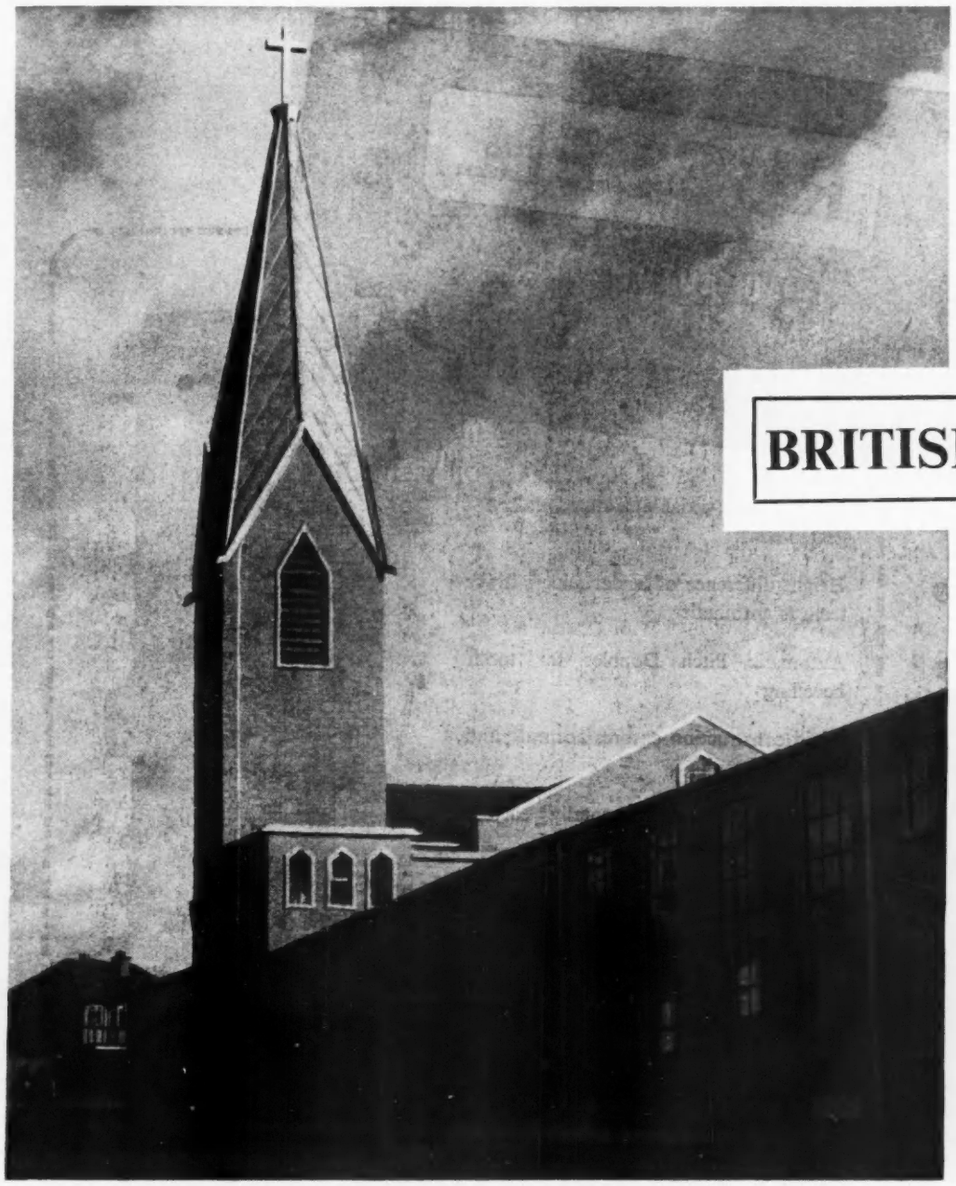

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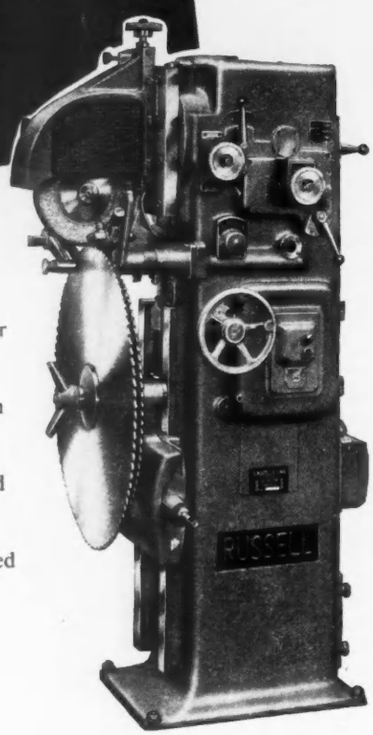

- Tooth form (variable) automatically generated
- Height difference of leader and follower teeth is automatic
- Automatic Pitch Doubler for tooth bevelling
- Rigid construction ensures accurate and rapid sharpening
- Operating mechanism totally enclosed and running in oil
- Built-in motor-driven dust exhauster
- Simple to operate

Damaged or broken teeth are caused by neglect. Economical saw blade life can only be obtained by keeping blades in good condition. This means frequent and regularly planned grinding. A machine specially designed to sharpen the tooth form of the modern circular cold saw blade provides the only efficient method of carrying out this operation.

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Valves, Cocks & pipe line fittings from Stock

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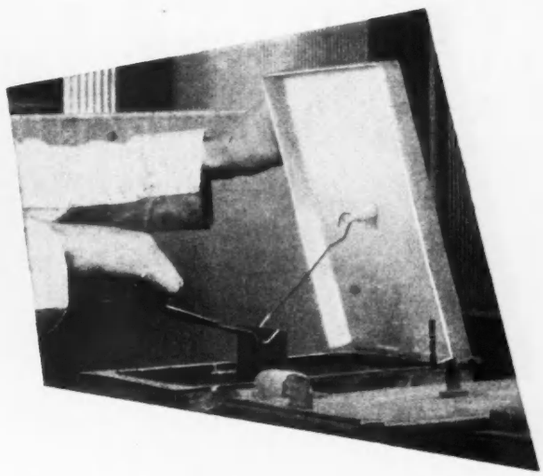

These hands are but a pair among many engaged in the continuous testing and experimental work carried out in P.J. laboratories, where skilled paint technicians tackle the complex problems which confront industrial paint users. Your area P.J. technical representative will bring you the services of this team of experts to advise and assist you with your finishing problems.

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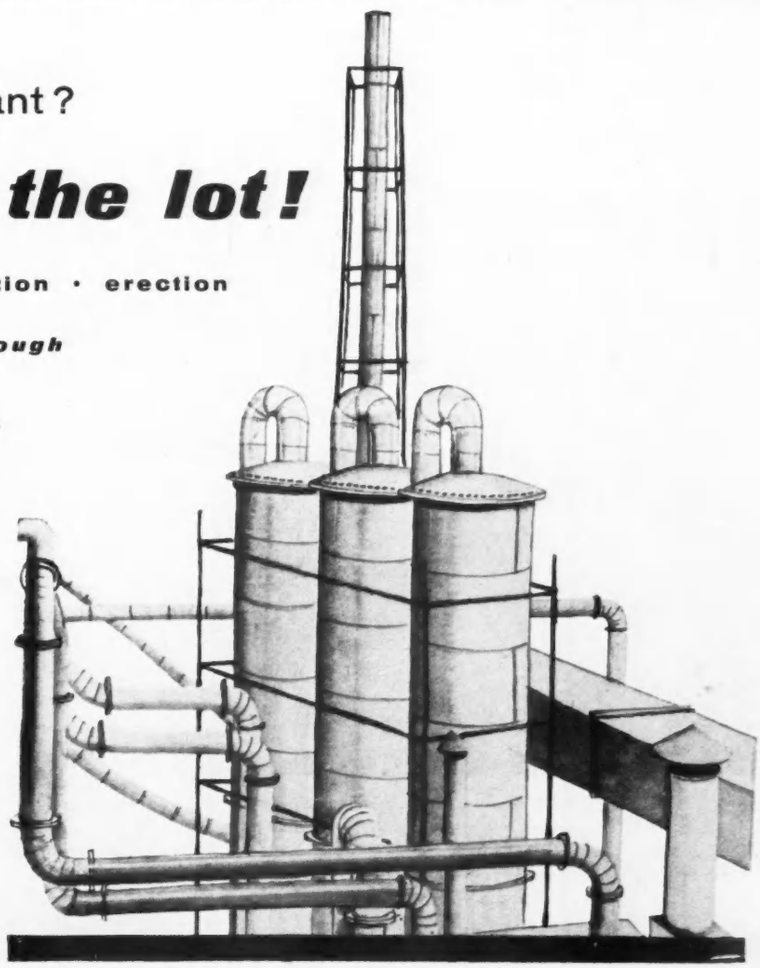
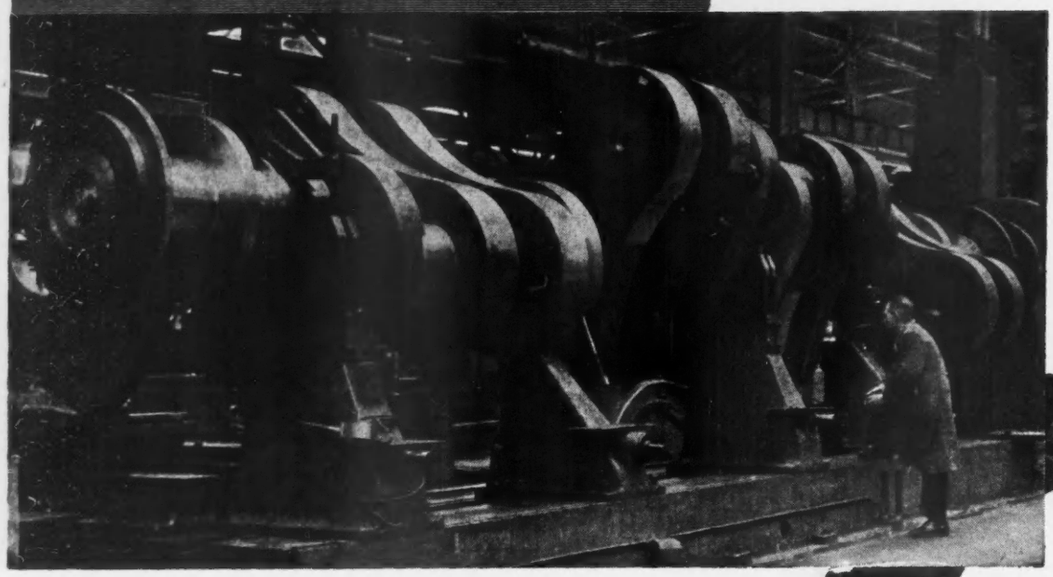


RUHRSTAHL

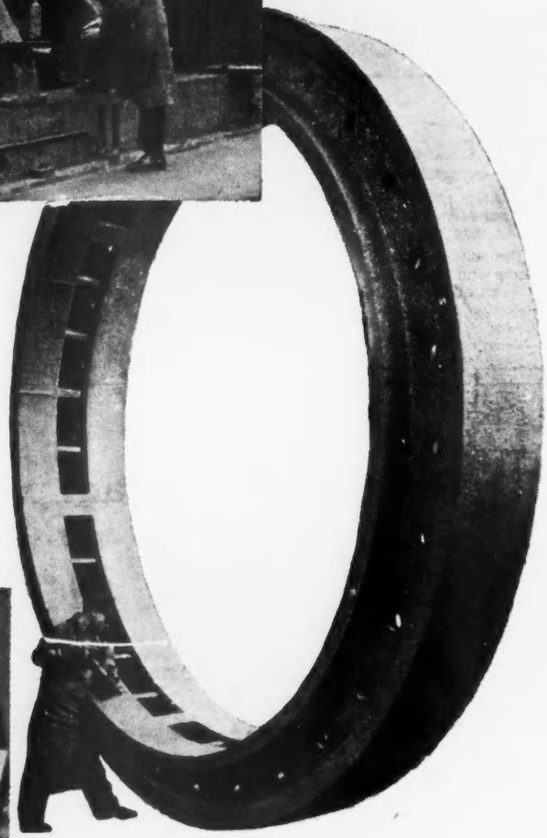
FORGINGS

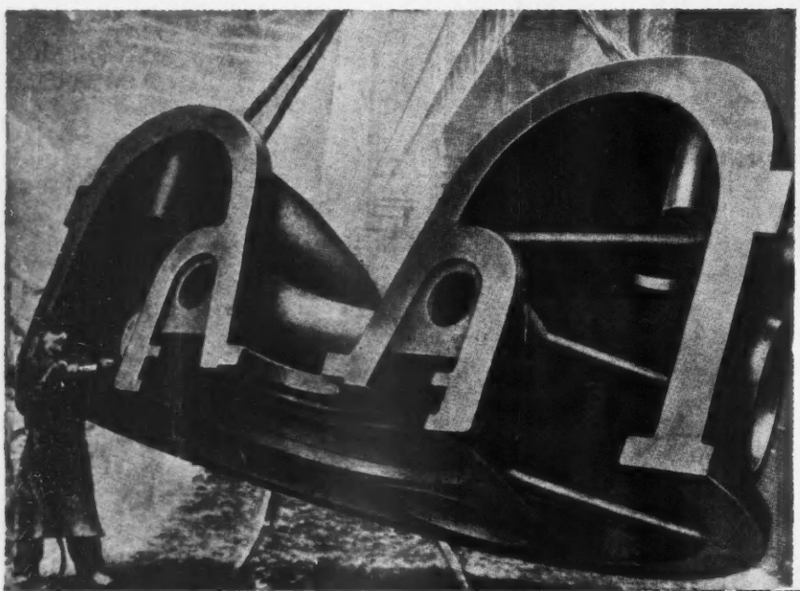
Up to a maximum ingot weight of 195 tons. Supplied in all states of finish from "black forged" to finish machined. The illustration shows a Doxford type crankshaft 33 ft. 4 in. long, weighing 42 tons.



STEEL CASTINGS

Ruhrstahl foundry is noted for production of steel castings up to a nett weight of 245 tons after fettling and castings of the largest dimensions. These can be supplied part or finish machined. The 15 ft. diameter carrier ring for a cement kiln, shown opposite, weighs 16 tons.





IRON CASTINGS

Castings up to 150 tons unit weight from grey cast iron to specific qualities are a feature of the plant. Machining to the degree required can be carried out. The casting opposite is a Steam Turbine Housing weighing 19 tons.

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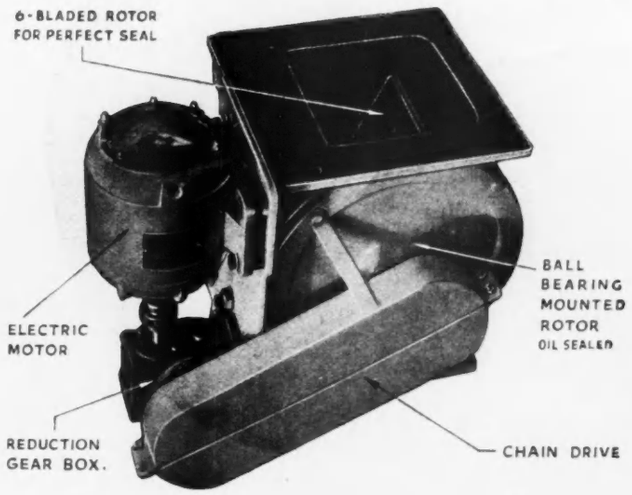

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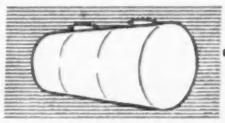
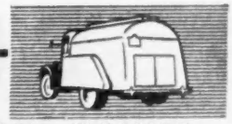


M.S.L

Electrically Welded



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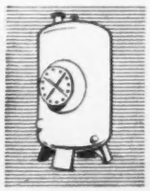

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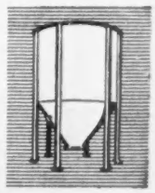

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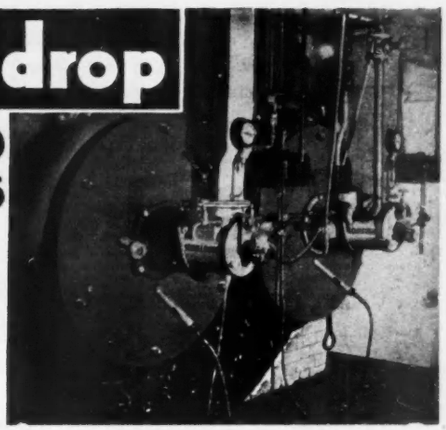

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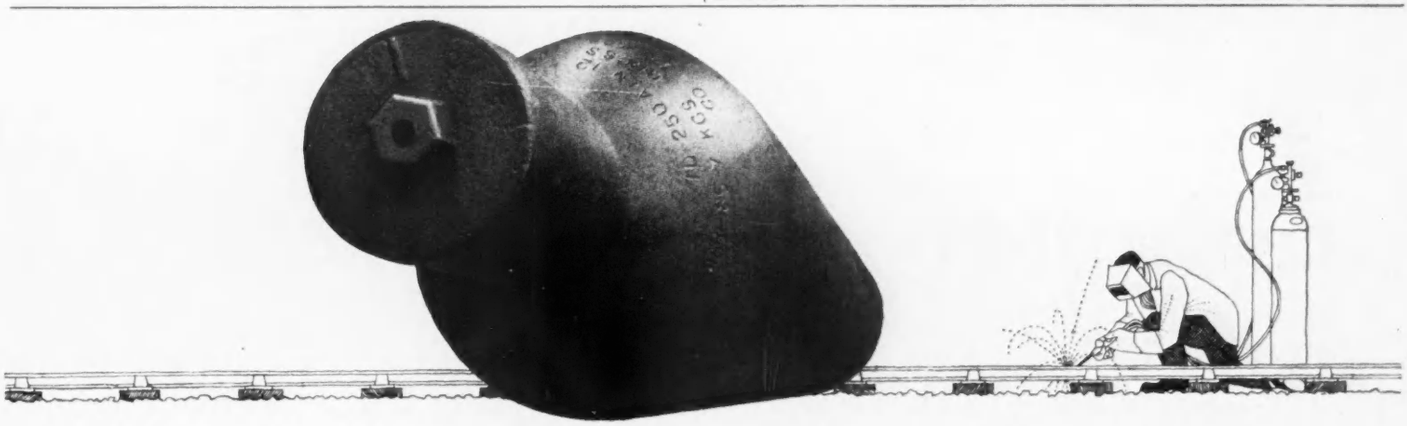

WHAT'S IN A TUBE?

At Chesterfield we can look back on over fifty years' experience in punching and drawing stubborn billets of steel into every shape and size of tube and hollow. This experience helps us to turn out impressive numbers of pressure vessels and gas bottles too. Whether you're on or off the beaten track, you are likely to come across the familiar shape* of a Chesterfield gas cylinder—one of over 9,000,000 already serving the needs of industry, medicine and construction the world over.

**Chesterfield gas cylinders are cold drawn, seamless and as perfect as our modern plant and manufacturing technique can make them. Chesterfield Cold Drawn Seamless Steel Gas Bottles are manufactured to conform to the specifications and regulations prescribed by the competent Authorities in all countries.*

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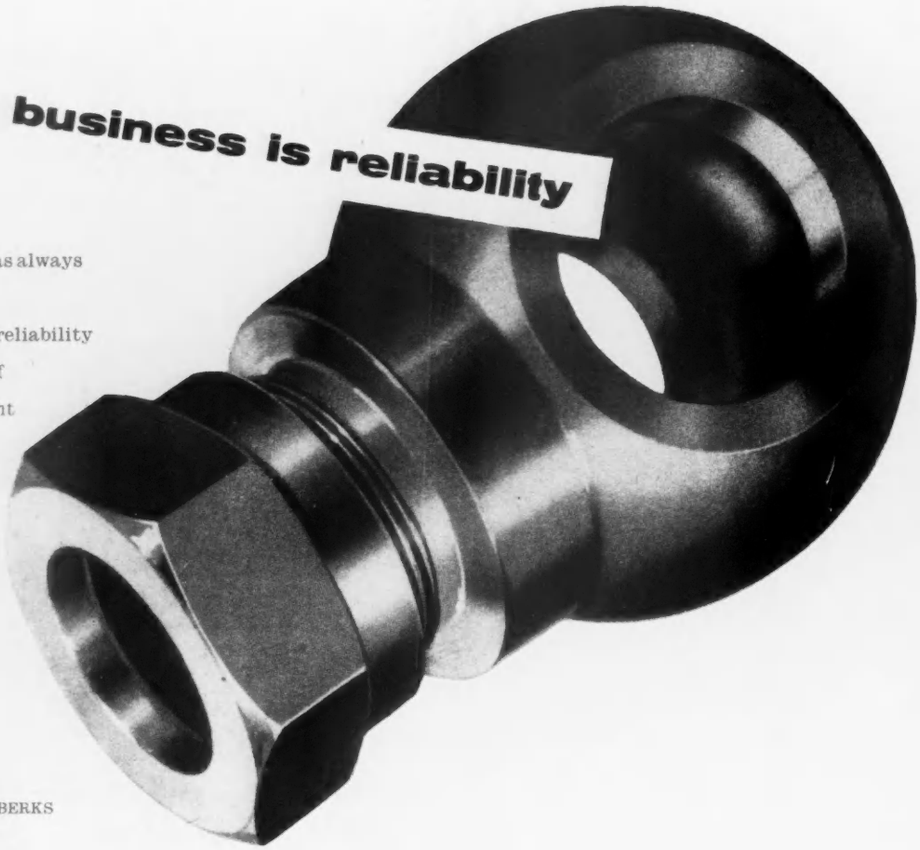
CBC 61

Our business is reliability



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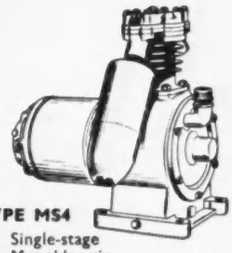
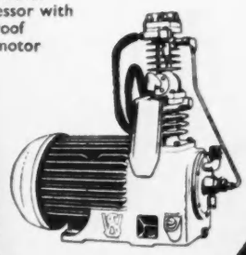
Two-stage Monobloc air compressor with intercooler and 10 h.p. totally enclosed, fan-cooled motor.

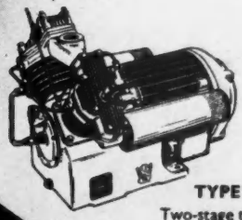


TYPE MS4
Single-stage Monobloc air compressor with drip-proof 1 h.p. motor



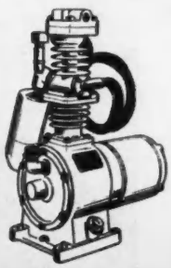
TYPE MTT8
Two-stage, tandem-type Monobloc air compressor with totally enclosed, fan-cooled 3 h.p. motor.

TYPE MSV55
Single-stage Monobloc air compressor with totally enclosed, fan-cooled 10 h.p. motor.



TYPE MS19
Single-stage Monobloc air compressor with totally enclosed, fan-cooled 3 h.p. motor.

TYPE MTT3
Two-stage tandem-type Monobloc air compressor, with drip-proof, 1 h.p. motor.



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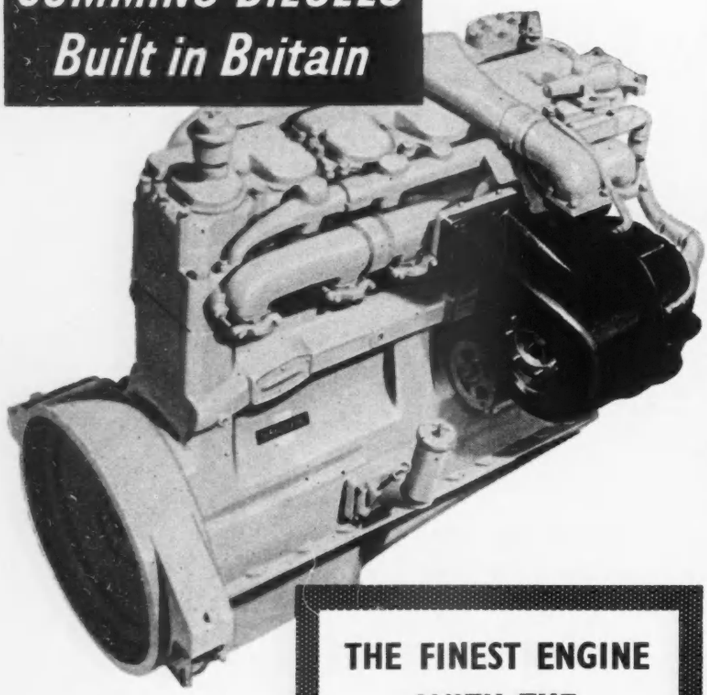
Built in Britain



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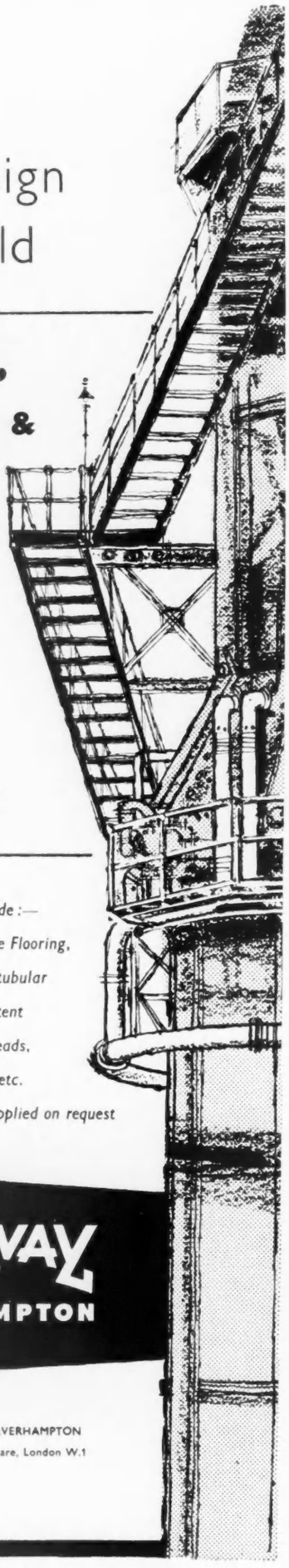

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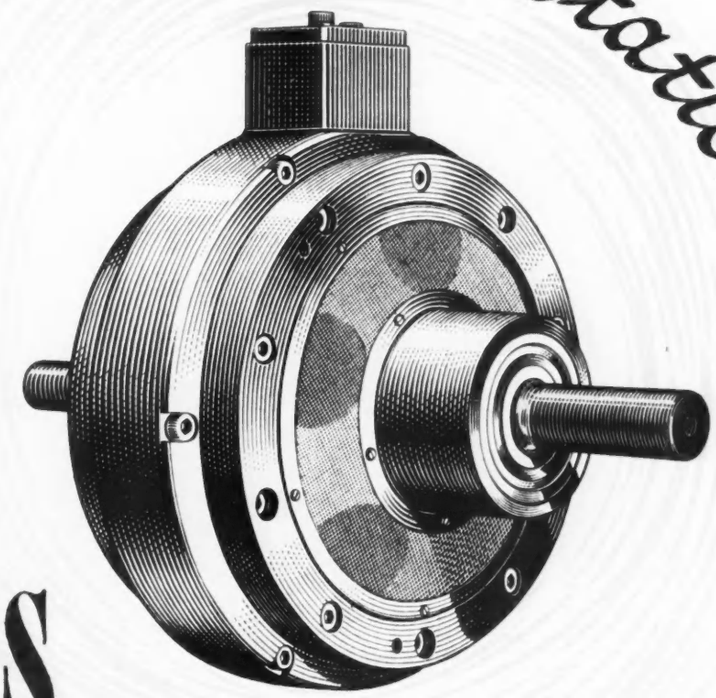

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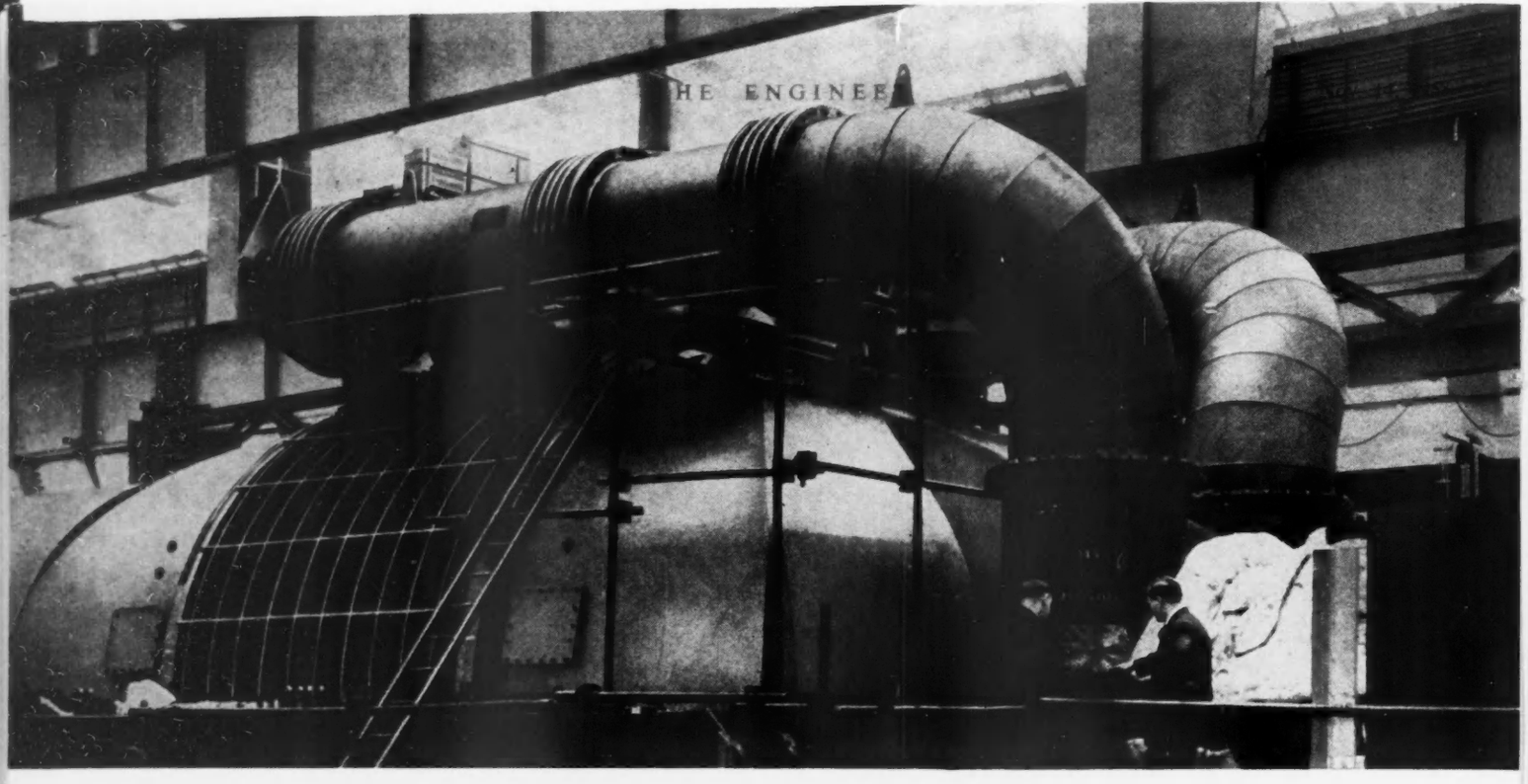

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the first 200 MW for Canada nears completion . . .

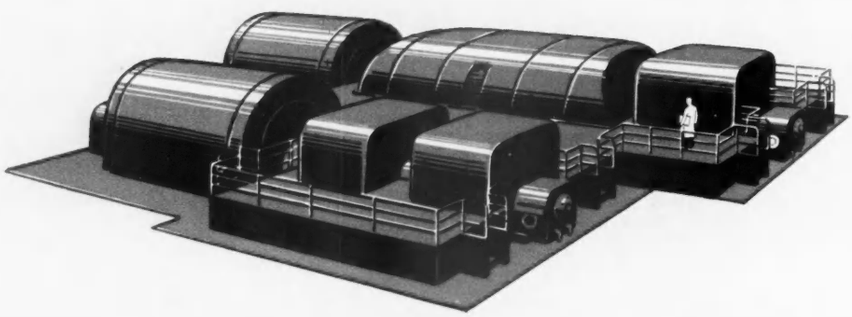
There are four of these 200 MW cross compound turbo-generators to be supplied to Canada for installation in the Hydro Electric Power Commission of Ontario, Richard L. Hearn generating station at Toronto. The first of these four machines is now nearing completion. They will be part of the largest power station in the world to install *all Parsons turbo-generators*—a total of four 100 MW sets and these four 200 MW sets.

PARSONS

TURBO-GENERATORS

. . . as preparations go ahead to build the first 300 MW

Two 300 MW cross compound turbo-generators have been ordered by The Hydro Electric Power Commission of Ontario for a new power station to be built at Lakeview, near Toronto. These are the largest machines to be ordered by Canada and they will operate with steam at 2,350 lb/in² pressure 1,000°F temperature and reheat to 1,000°F.



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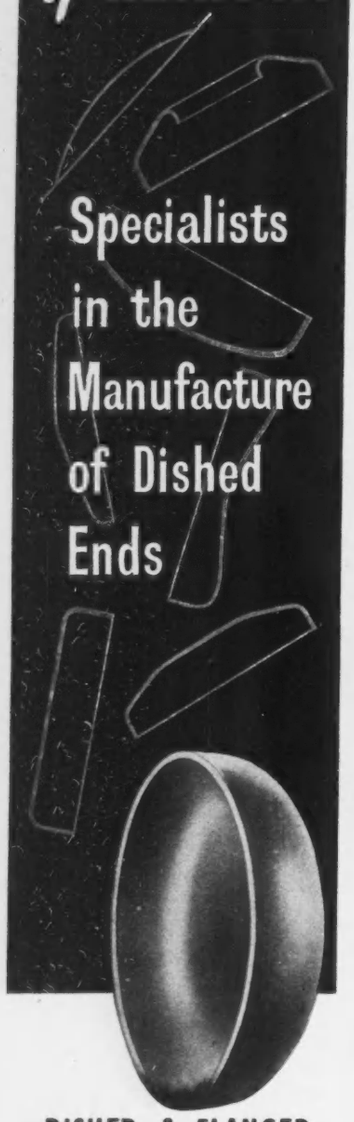

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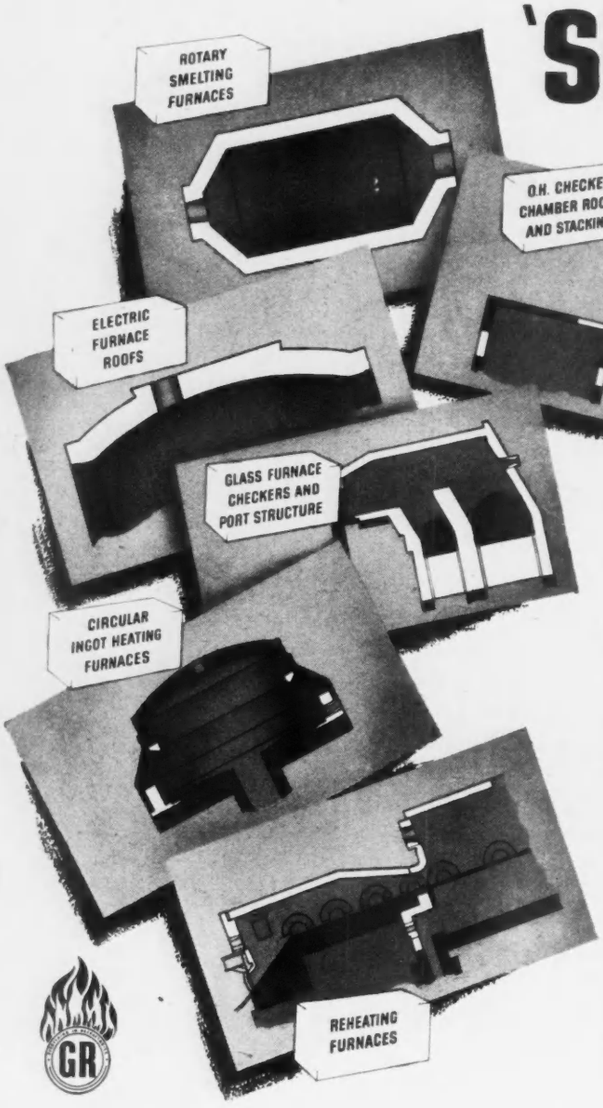

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GR 'SILLMAX' 63/100 Group Bricks

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For use under extremes of operating conditions these bricks are based on Corundum and highest quality Sillimanite. Two grades available

75 Conventionally fired
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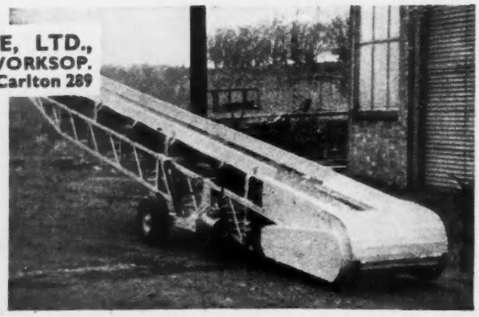

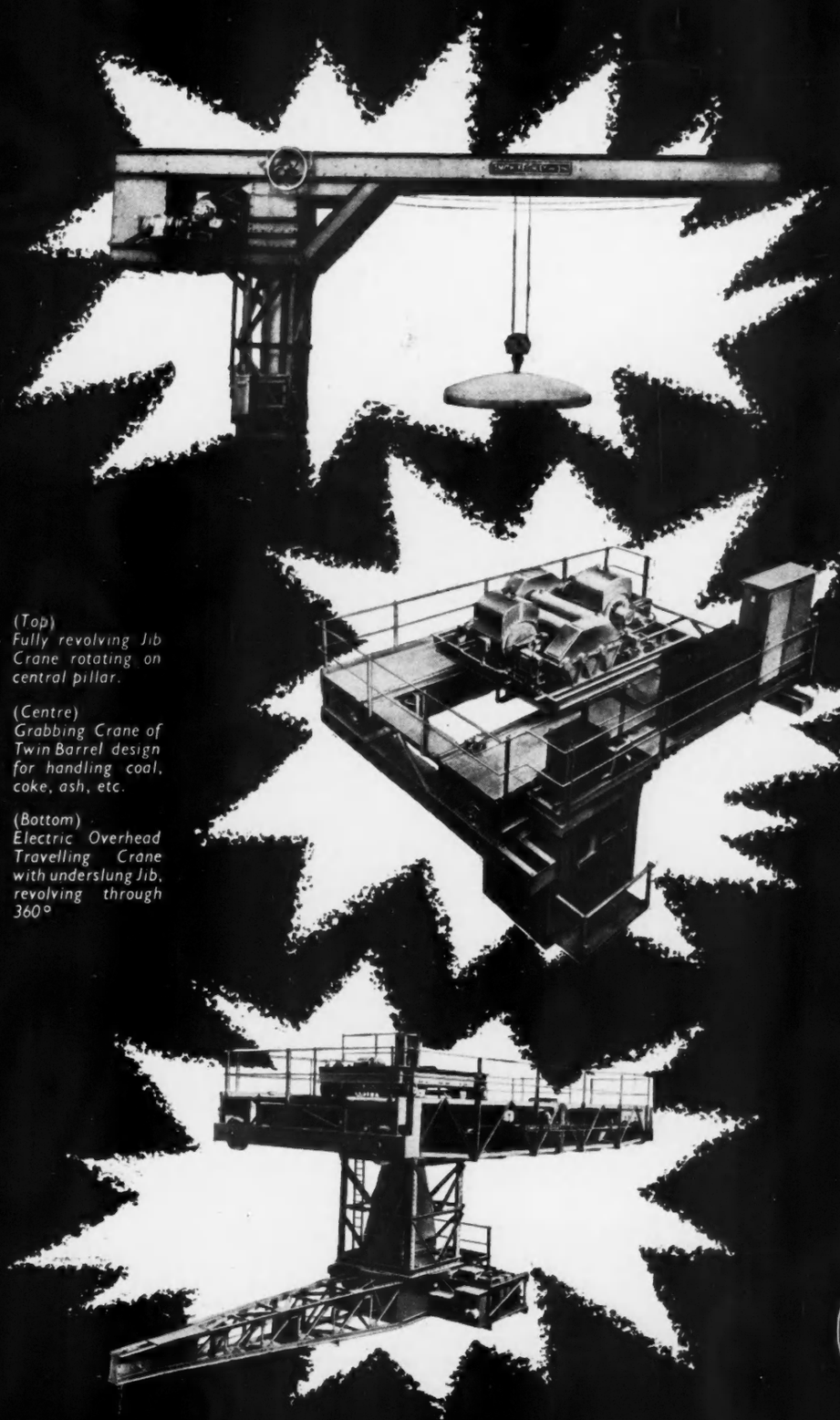

(Top)
Fully revolving Jib Crane rotating on central pillar.

(Centre)
Grabbing Crane of Twin Barrel design for handling coal, coke, ash, etc.

(Bottom)
Electric Overhead Travelling Crane with underslung Jib, revolving through 360°

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John Smith CRANES

Special handling problems can only be solved by the installation of cranes designed to meet the particular needs of prevailing conditions. The illustrations show three completely different types of cranes built to meet customers requirements. Over the years the designing and building of special cranes has been OUR JOB, and if you require our assistance, we will visit site and then submit designs for your approval.

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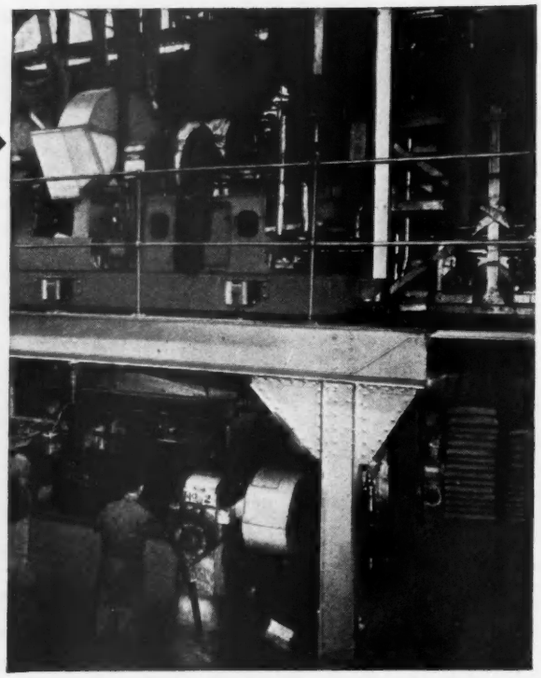

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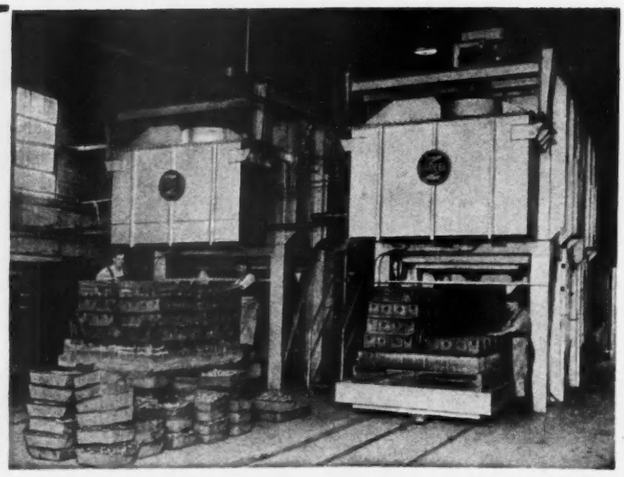

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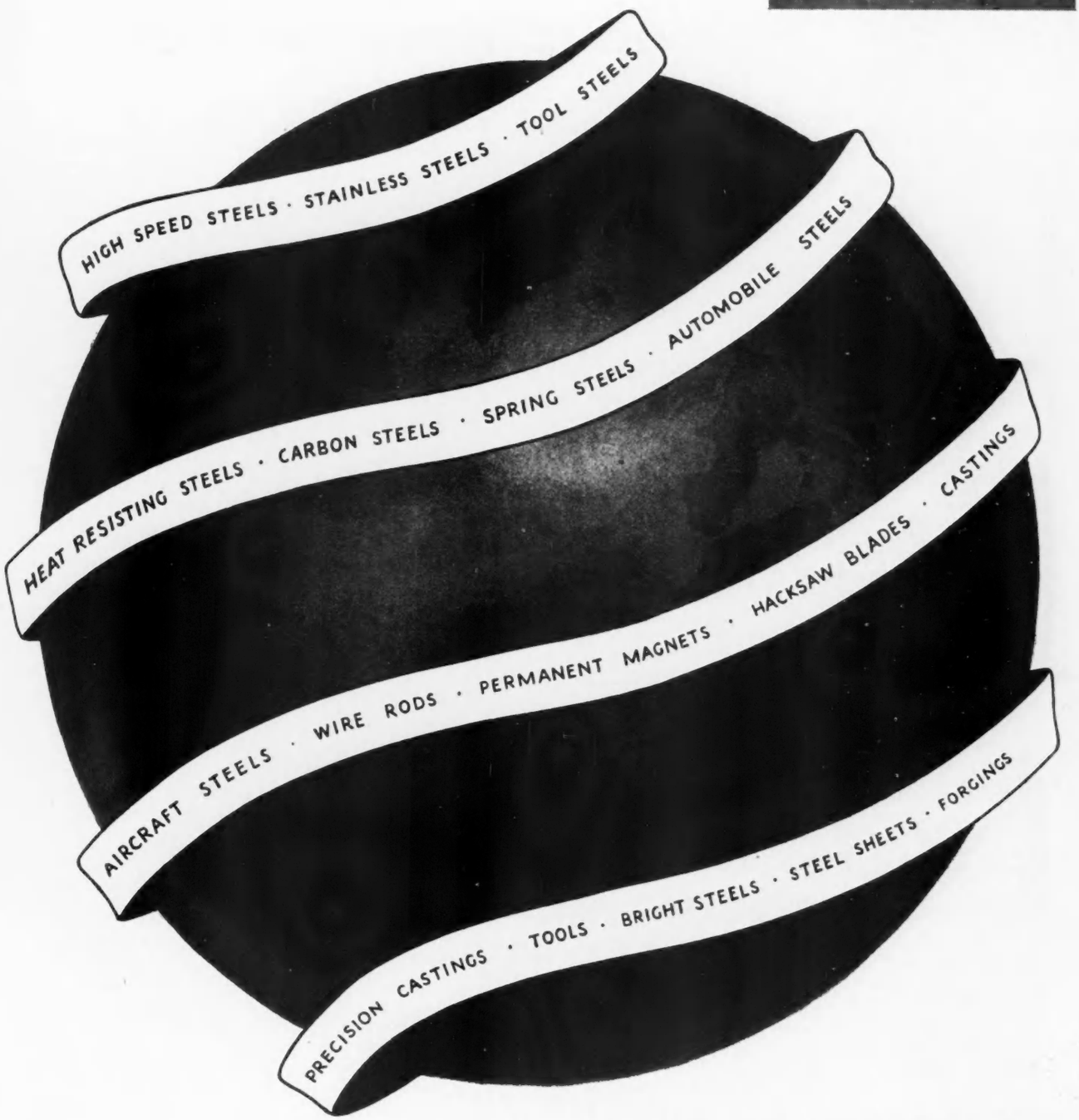
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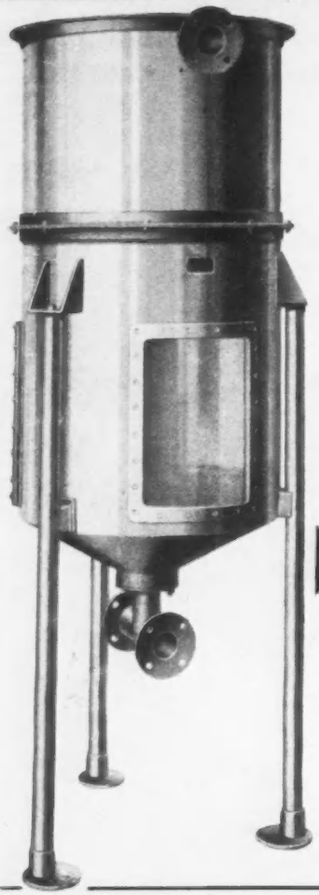

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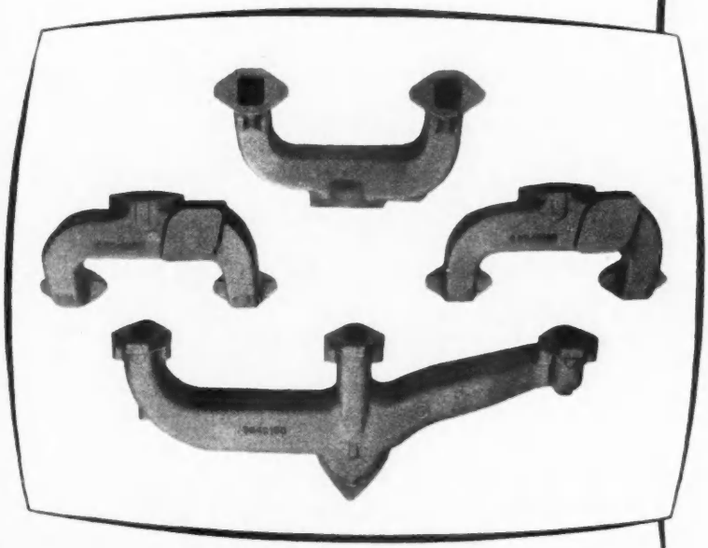

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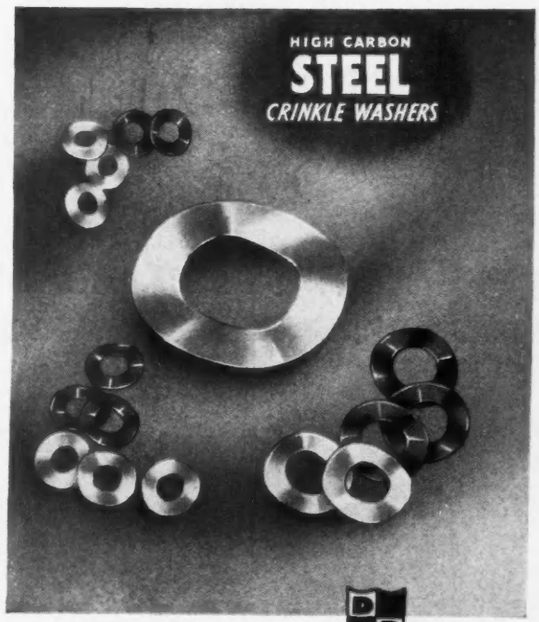

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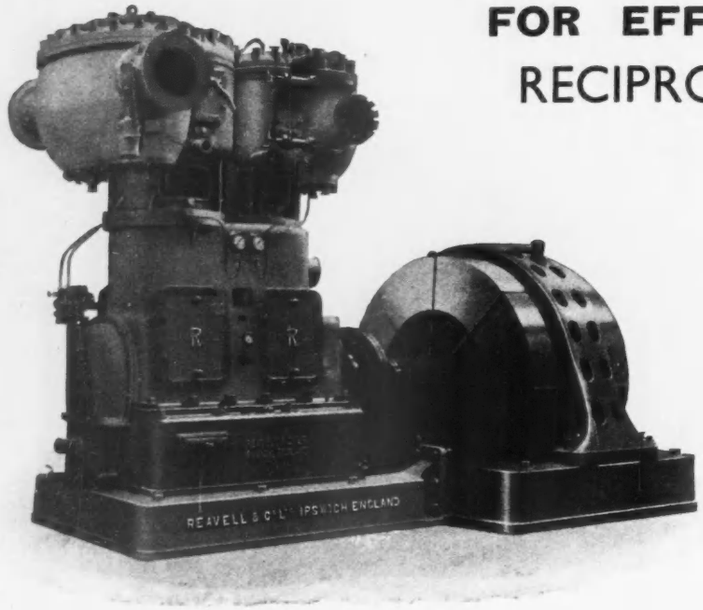

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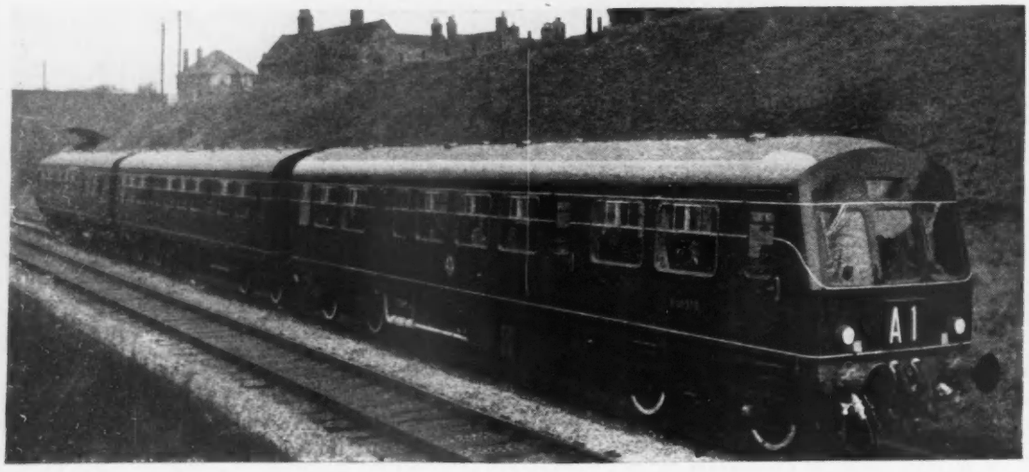

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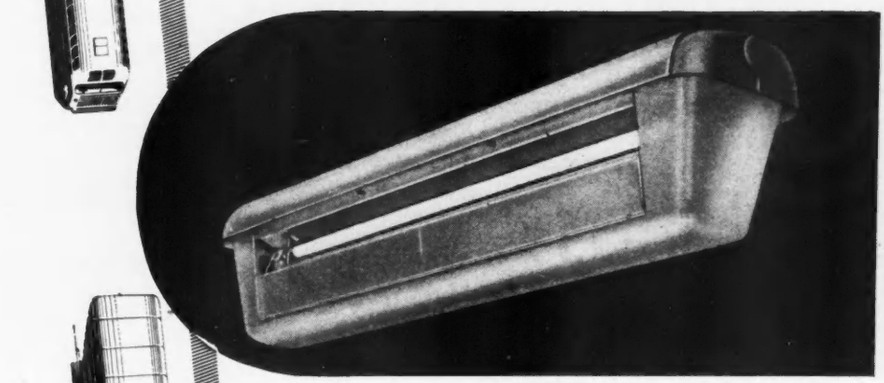

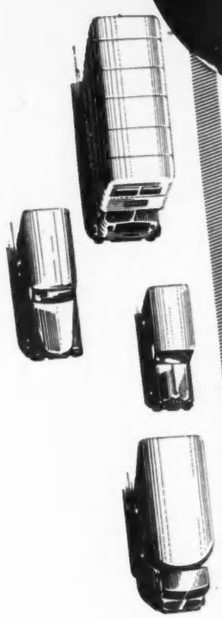

The lantern, which has been designed for use on main roads, houses three 5 ft. 80 watt Osram fluorescent tubes. Among the entirely new features of this lantern are :—

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- Tube operating gear housed within the lantern body.
- Hinged top to the body enabling the tube operating gear to be examined the right way up.

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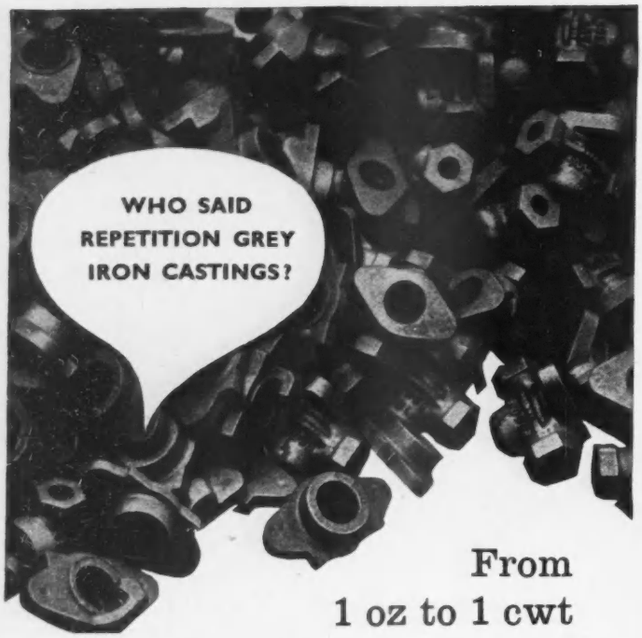

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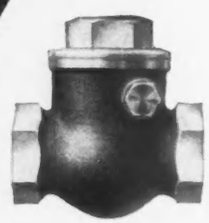

1060A HORIZONTAL or VERTICAL CHECK VALVE

Swinging type. Sizes ⅜"-2"—Female ends tapped BSPT (taper) BS21 2½"-3"—Female ends tapped BSPT (par) BS84.

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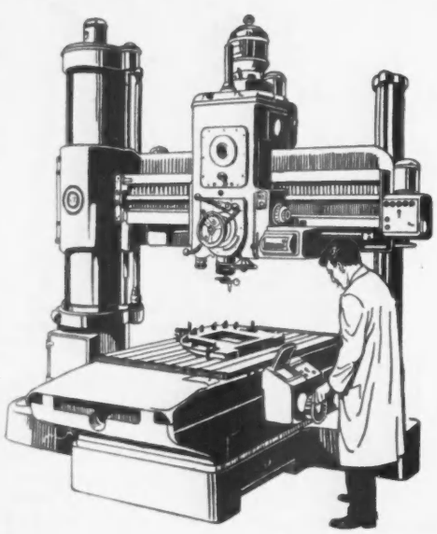

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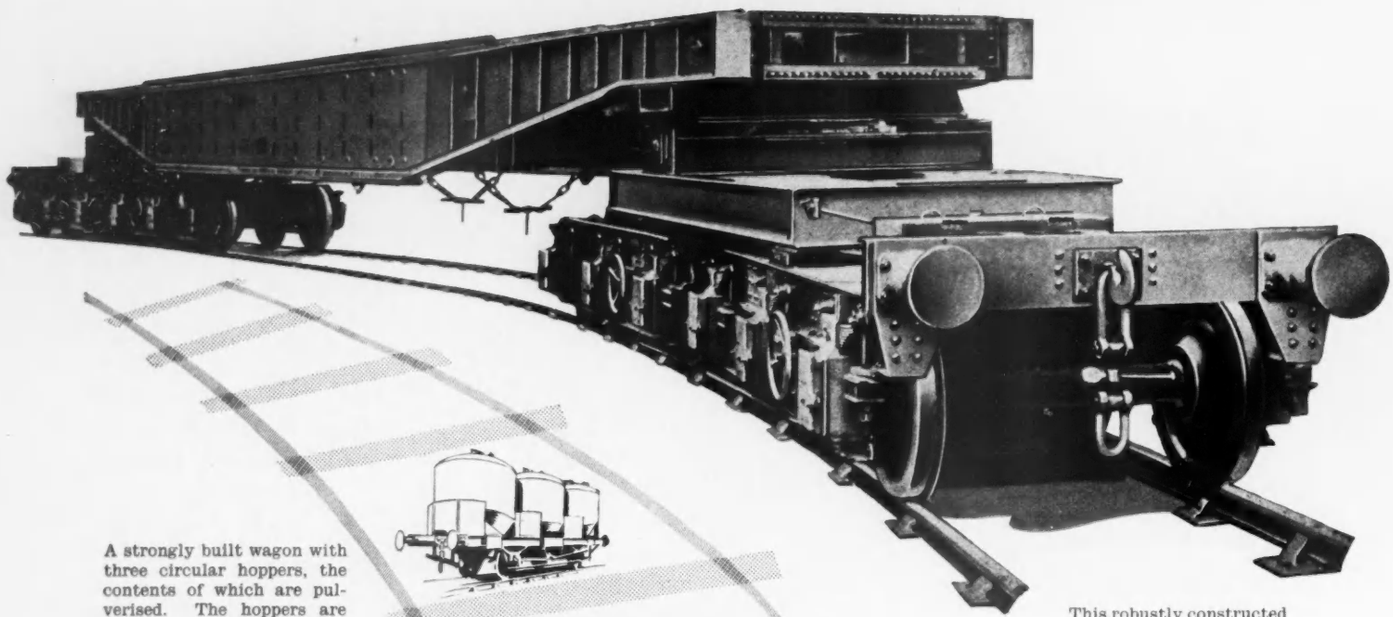
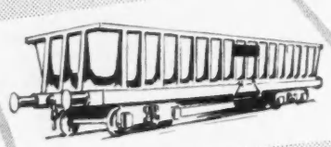
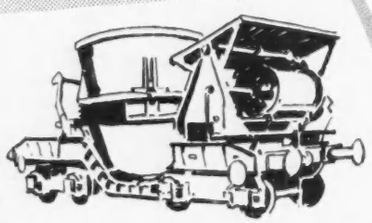


This robustly constructed transformer wagon can carry 135 tons and has four six-wheeled bogies.

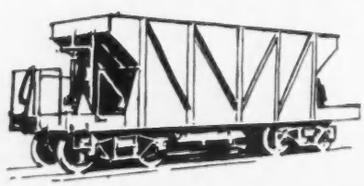
A strongly built wagon with three circular hoppers, the contents of which are pulverised. The hoppers are discharged by compressed air.



This heavily constructed wagon is welded throughout, and designed primarily for carrying pig iron.



A welded steel carriage carrying a 400 cu. ft. Treadwell tipping slag ladle. Tipping is effected by means of steam or air.



Another example from the extensive range of Head Wrightson rolling stock, this bogie hopper wagon carries 40 tons and has transversely hinged doors.

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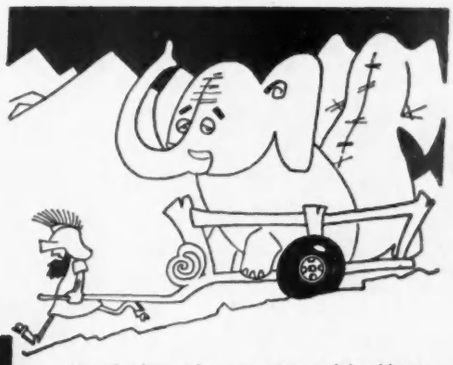

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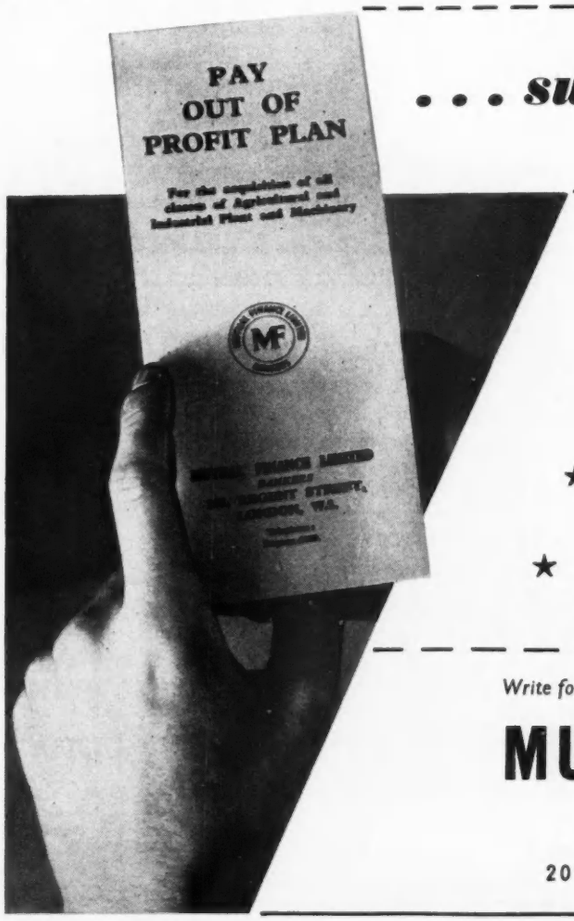

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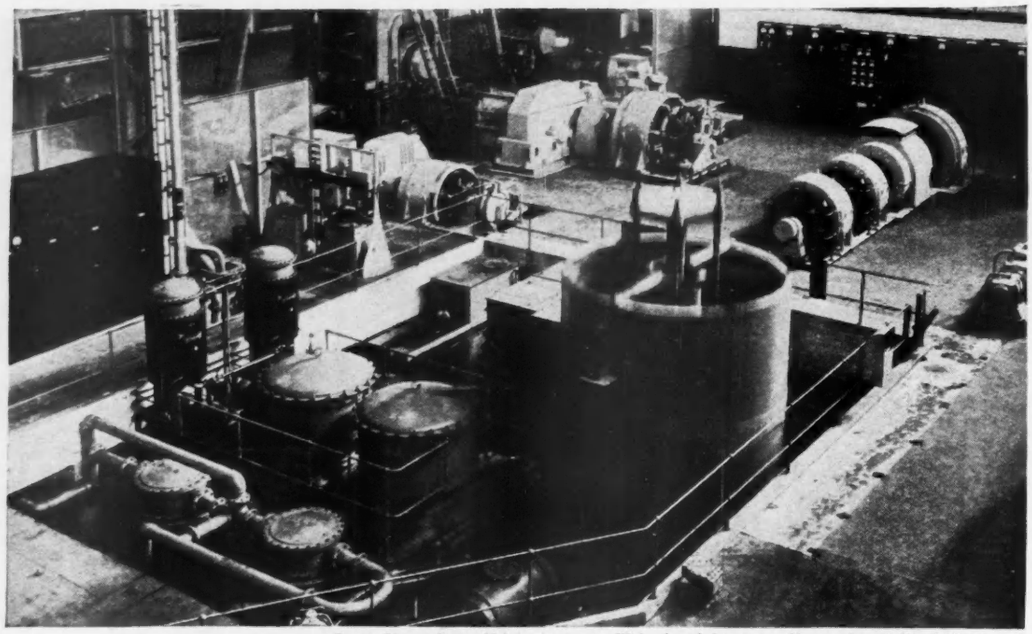

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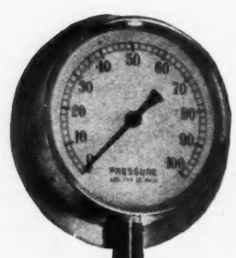

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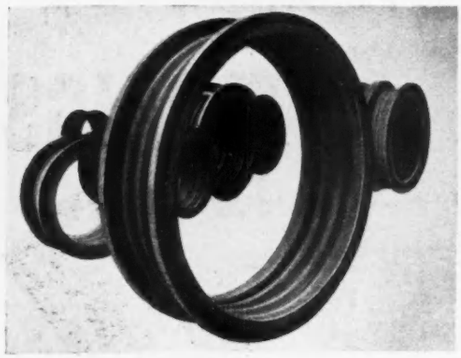

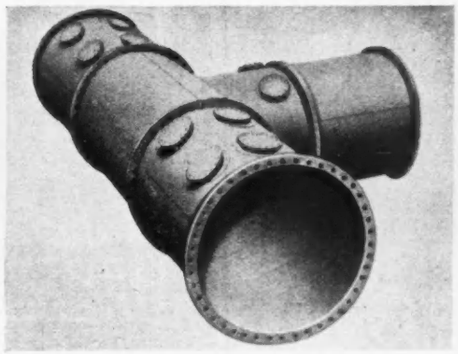

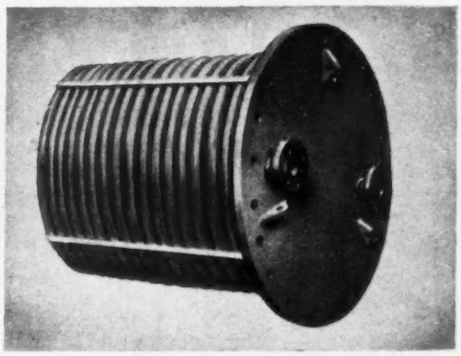

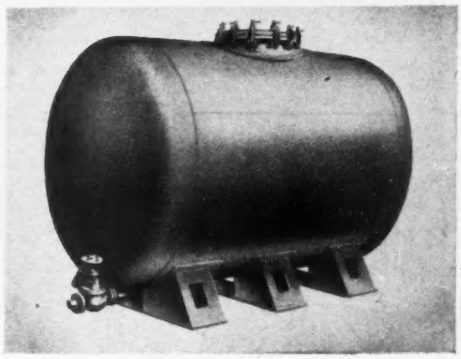

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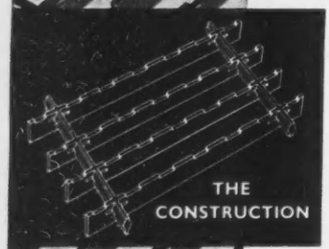

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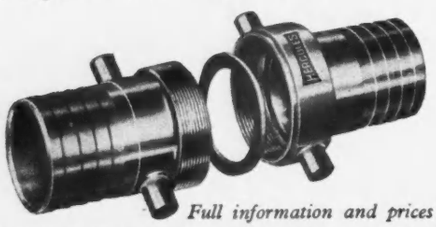

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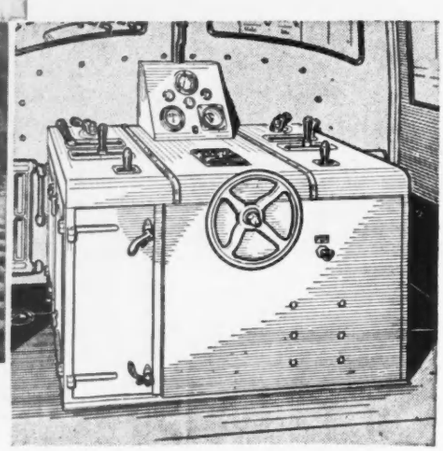

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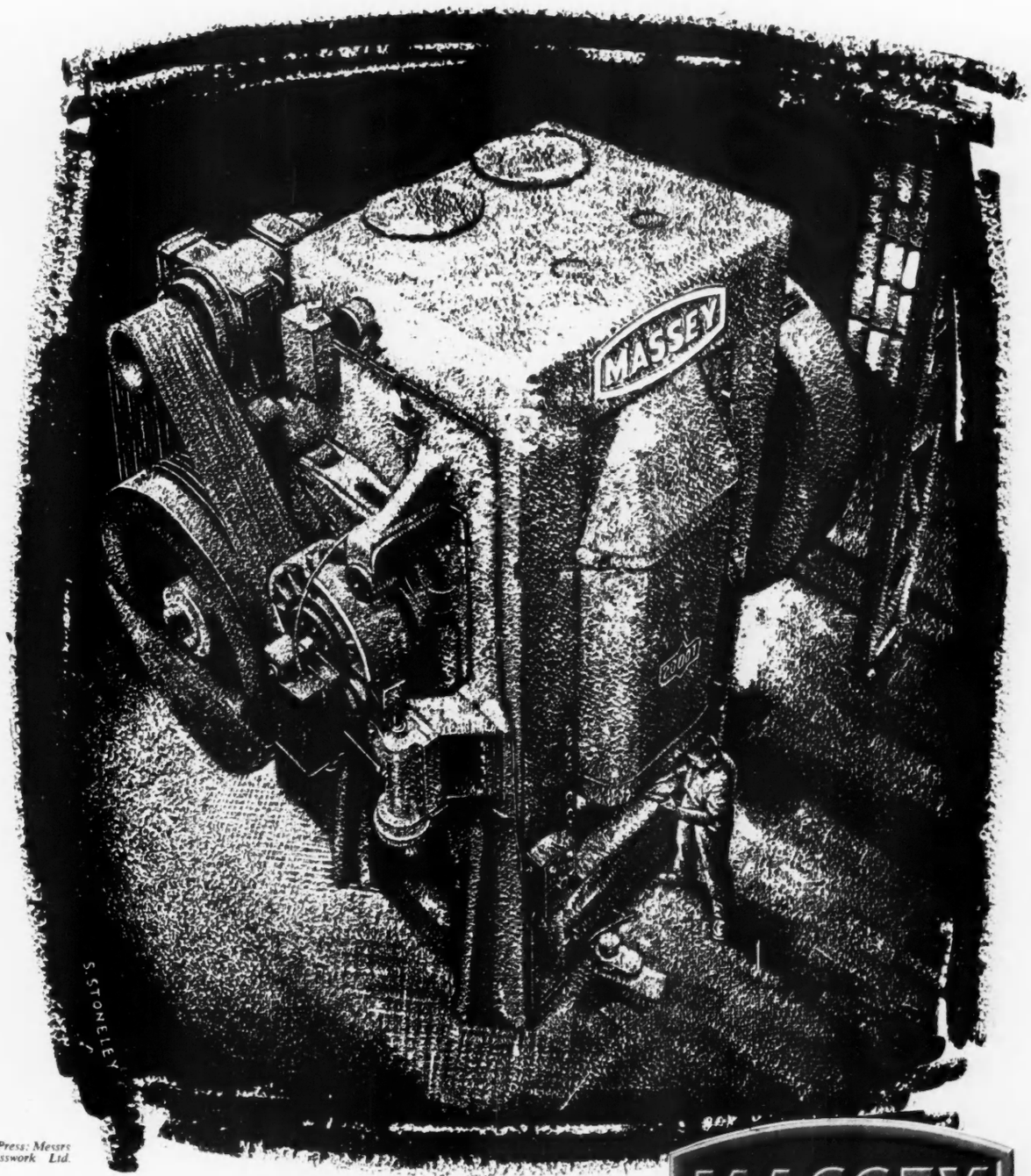

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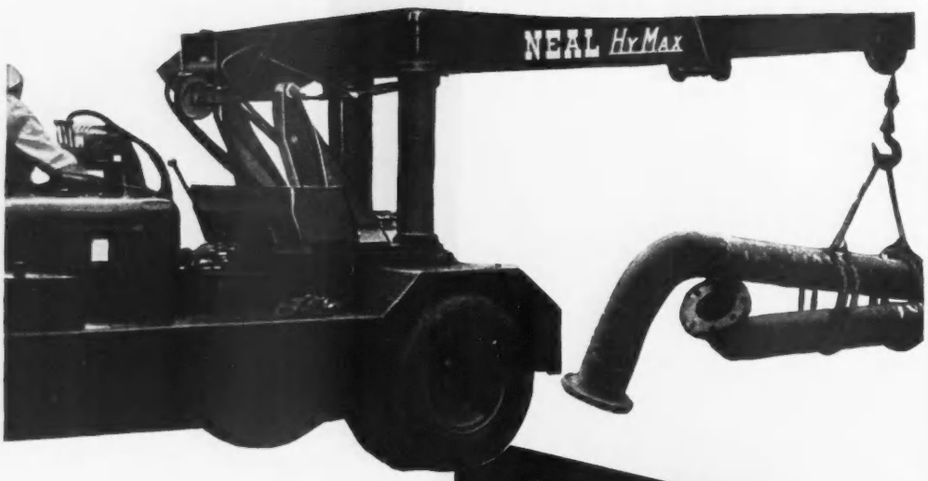

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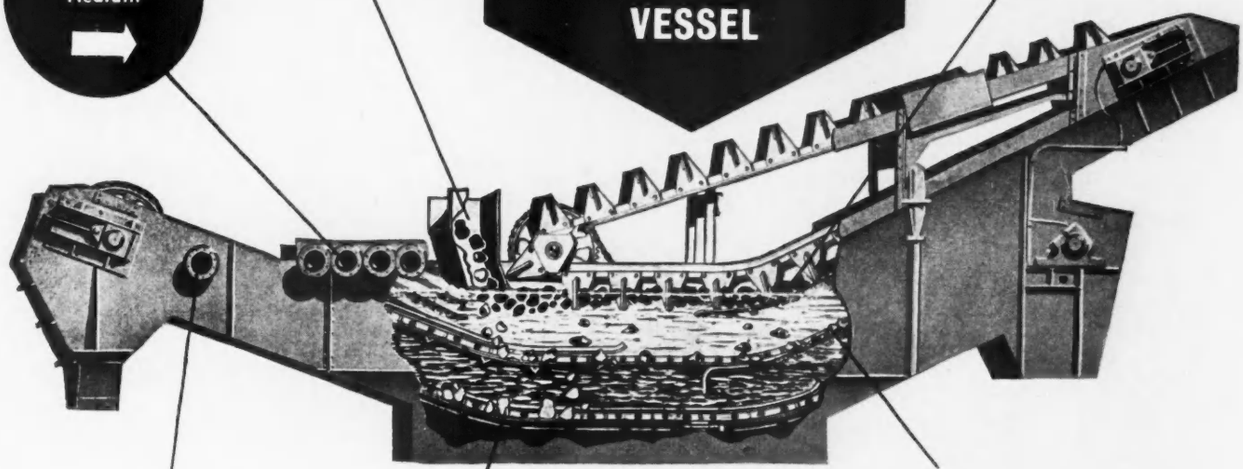

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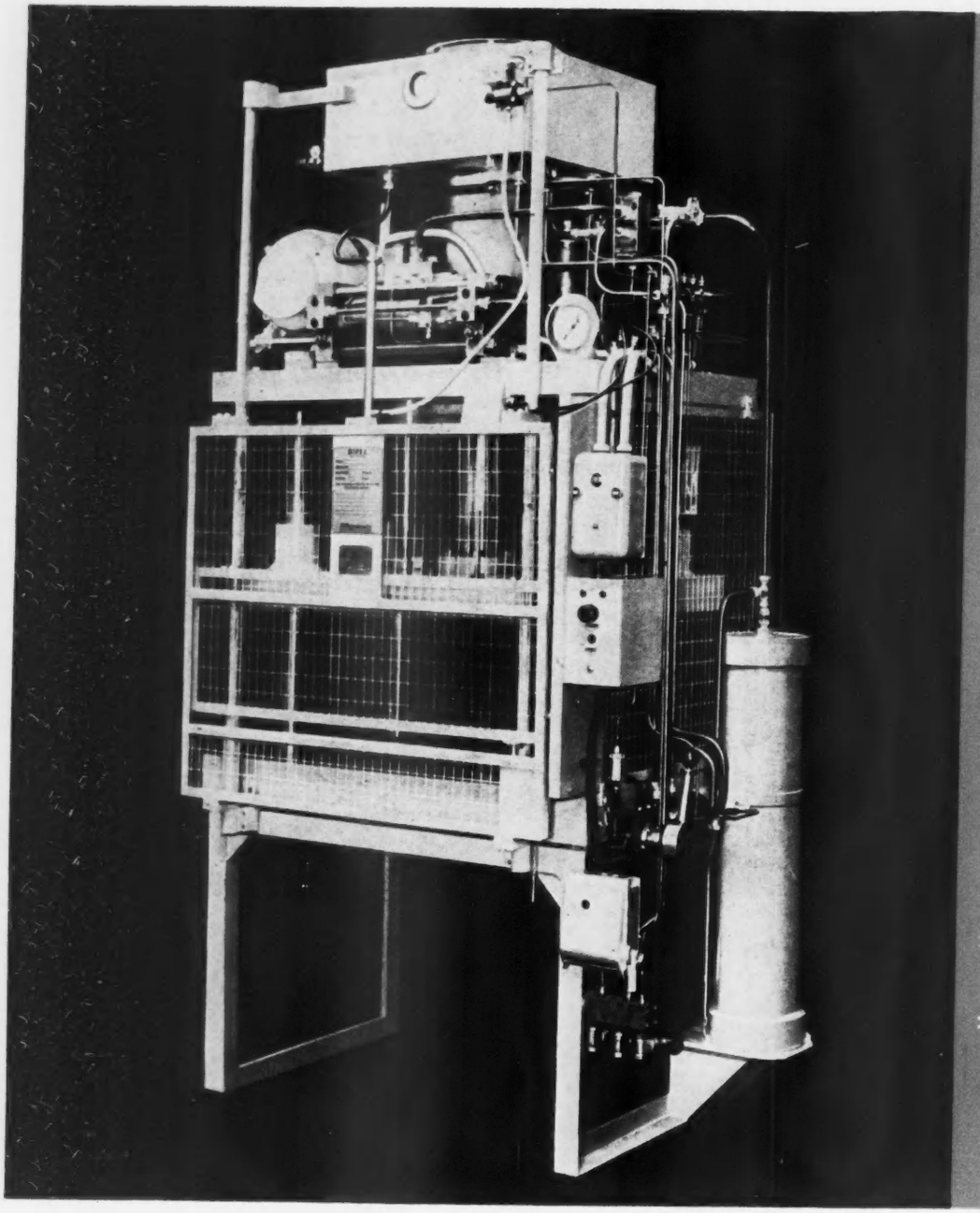

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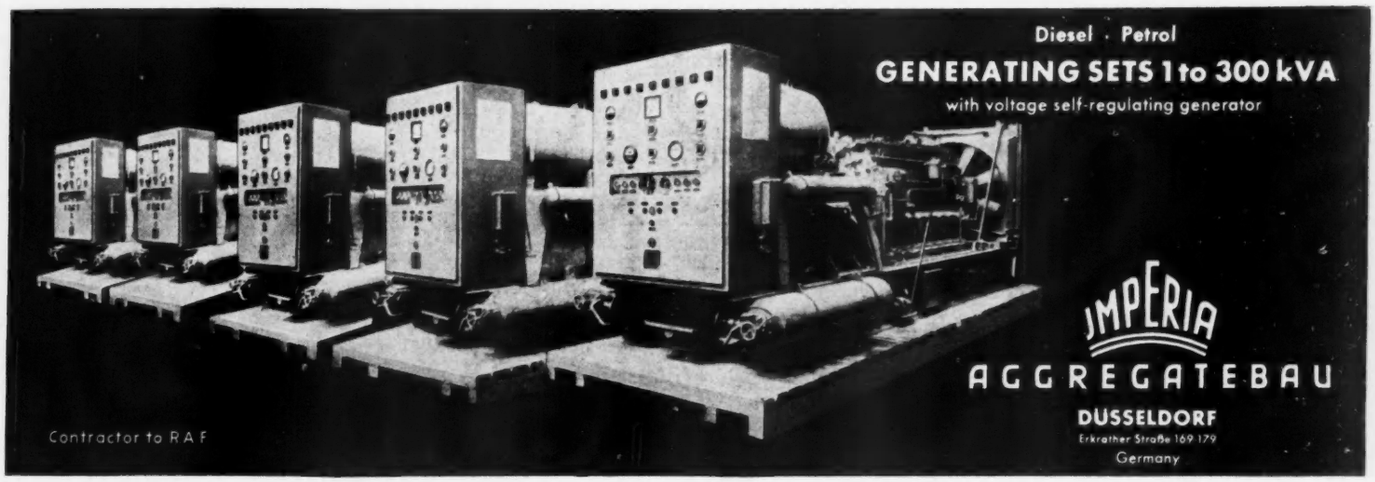

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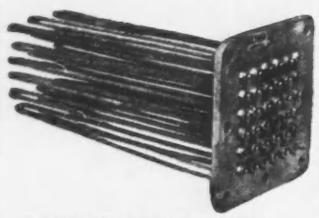

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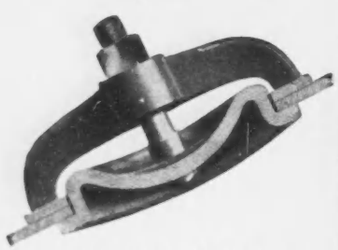

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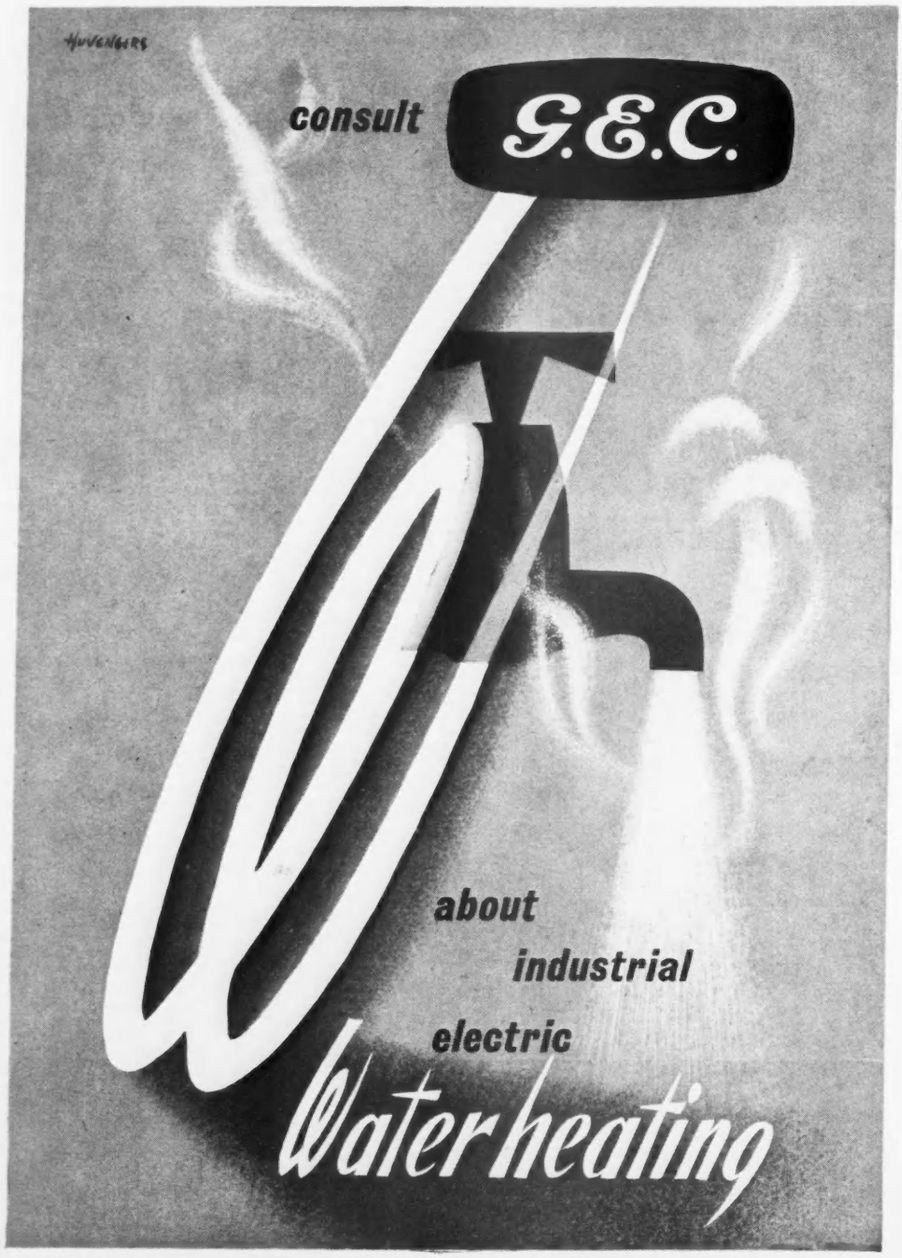

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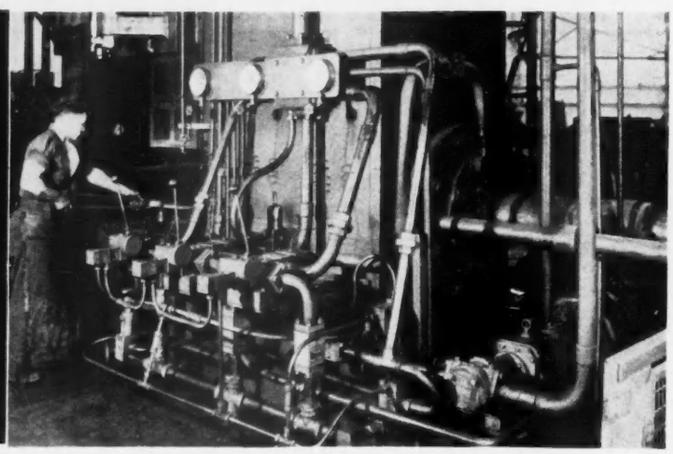

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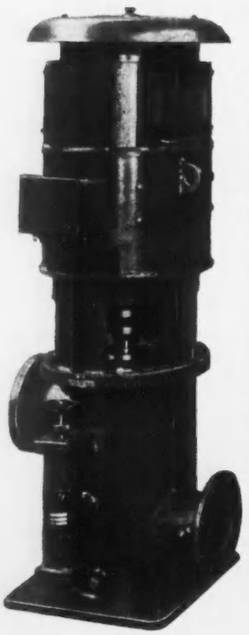

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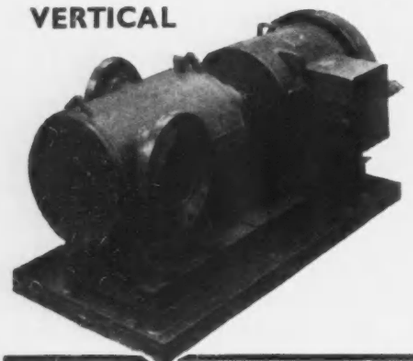

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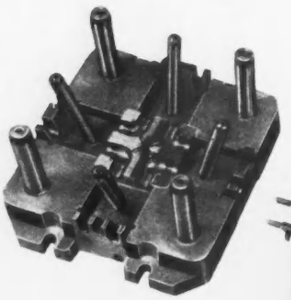

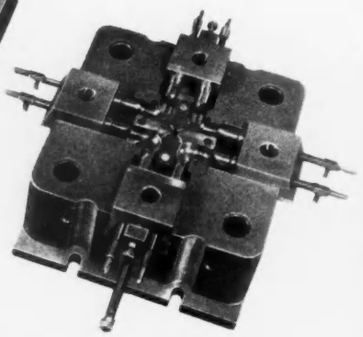

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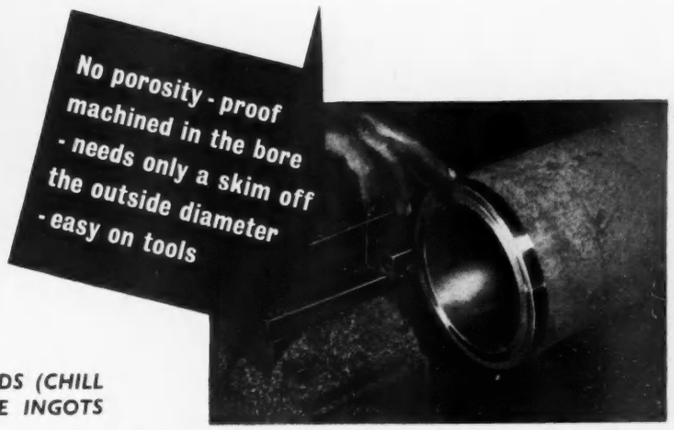

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THE FINANCIAL TIMES WEDNESDAY SEPTEMBER 17 1958

Rapid Progress at Kariba

By Our Rhodesian Correspondent

Half the main wall of the Kariba Dam is now in place. Every month another 90,000 cubic yards of concrete are poured between steel shuttering rigged on the rising crests of the 42 blocks curving across the Zambesi.

Cables span the river, supporting three Bloodin buckets which shuttle back and forth, bringing 20 [illegible]. The buckets are "talked down" to operators using portable radio-telephone sets. The construction programme has been accelerated, following the unprecedented flood last February.

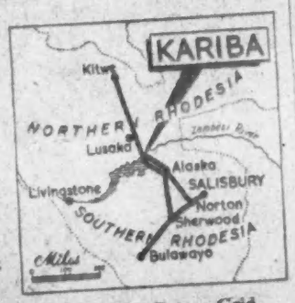
The four gaps left in the base of the wall to permit the river to pass will be sealed before the end of this year. By mid-1959 the stored water will be more than half-way up the 400-foot-high wall, which itself will then be complete—eight months earlier than originally planned.

Peak Effort

The general manager of Impreg Kariba (Pvt.), the main civil engineering contractors, told me that the were now at the peak of the effort, with 1,000 Europeans and 5,500 Africans engaged. The number employed would be reduced steadily from next March. The had experienced some difficulties but none of these was insuperable.

The deputy chief executive of the Federal Power Board estimated the direct cost of the recent flood damage at around £300,000. Part of this, he added, would be recoverable from insurance. The indirect costs incurred by accelerating the construction programme and increasing the number of spillway gates from four to six would be somewhat more than £750,000.

On the credit side, the flood had called attention to the bigger potential of the catchment and this would result in a small but useful [illegible] of units that



The New Power Grid.

be borne by the scheme on amortisation Stage 1 are based on amortisation over 20-30 years—a period unrelated to the true life of the plant and civil works. However, the high load factor to be expected must eventually make Kariba power one of the world's cheapest sources of energy.

Meanwhile, the new Federal grid is rapidly taking shape. The trunk

The first of the [illegible] being supplied by power turbines, being erected at the Boving, is now being erected at the site and the first of the six 100mW generators to be manufactured by Metropolitan-Vickers will be shipped from Britain next February. Two 200-ton overhead electric travelling cranes supplied by Babcock and Wilcox for handling the plant in the [illegible] already been

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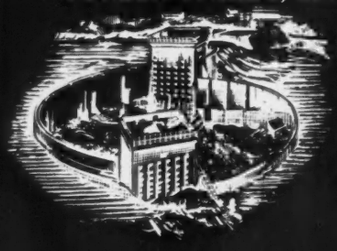
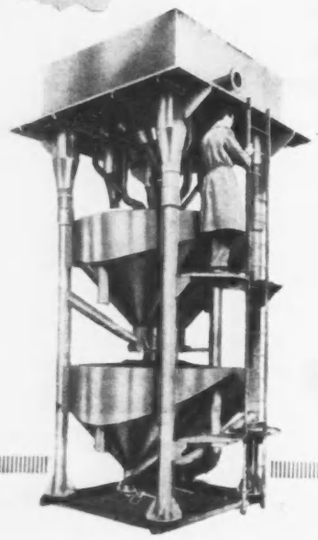
RHEAX HYDRAULIC CLASSIFIERS

are in use at KARIBA GORGE on the Zambesi River, boundary between Southern and Northern Rhodesia, where Africa's largest Hydro-Electric Power Station is being built. RHEAX past and present installations also include Ybbs-Persenbeug Austria, Zervreila Switzerland, Serre Poncon France, Luenersee Austria, Campo Moro Italy, Gioveretto Italy, Gougra Switzerland, Roselend France, Malvaglia Italy, Jochenstein Austria, Grandval France, Kaprun Austria, Vaiont Italy, Mae Italy, Frera Italy



Classified Sands mean better concrete



Do you want a Silt-Free Sand? A special fine aggregate? Better sand grading means better quality concrete to suit your specifications. Rheax Sand Classification offers you:—

1. Sand specially graded to your exact requirements.
2. A hydraulic separator that actually SEPARATES.
3. Separations at any required size between mesh 7 and mesh 150 at any required capacity.
4. No moving parts to maintain.

Send now for full details of Rheax Sand Classification to:—

MILLARS' MACHINERY COMPANY LTD

Pinners' Hall, Great Winchester Street, London, E.C.2.
Telephone: London Wall 4266/9, 4260, 1521/5. Telegrams: Milamax, Stock, London.

CLASSIFIED ADVERTISEMENTS

AGENCIES · DIRECTORS · PARTNERSHIPS · SITUATIONS VACANT · EDUCATIONAL PATENTS · BUSINESS OPPORTUNITIES · MISCELLANEOUS · PUBLIC APPOINTMENTS BUSINESSES and PREMISES · TENDERS

Lineage Rate. 4/- per line of approximately 6 words. Minimum 16/-

Inch Rate. 48/- per single column inch and *pro rata*. 12 lines to 1 inch.
There are reduced rates (*i.e.*, not on a *pro rata* basis) for advertisements of ¼-page (12 column inches) and upwards, e.g., ¼-page £25 10s. ½-page £48. Full page £90.

AUCTION SALES · FOR HIRE · MACHINERY, etc., WANTED · SITUATIONS WANTED DRAWING AND DESIGN SERVICES · FOR SALE · SUB-CONTRACTING

Lineage Rate. 3/6 per line of approximately 6 words. Minimum 14/-.

Inch Rate. 42/- per single column inch and *pro rata*. 12 lines to 1 inch.
There are reduced rates (*i.e.*, not on a *pro rata* basis) for advertisements of ¼-page (12 column inches) and upwards, e.g., ¼-page £22. ½-page £41 10s. Full page £78.

Series Discounts. For advertisements 1 inch and upwards. 6 insertions 5%. 13 insertions 10%. 26 insertions 15%.

Run-on and Semi-Displayed Styles. Both these styles are available for single column width advertisements of any depth up to 12 inches.

Displayed and Illustrated Styles. The minimum size for a Displayed advertisement is 3 inches single column, for an illustrated advertisement it is a ¼-page (12 column inches). Thereafter the sizes for both progress in steps 3 inches deep across 1, 2, 3 or 4 columns.

Use of Box Number. 2/- which includes forwarding of replies.

Copy Dates. "Run-on" and "Semi-displayed" advertisements by noon Tuesday for publication on Friday same week. "Displayed" and "Illustrated" advertisements by noon Friday for publication on following Friday. All advertisements three days earlier if proofs are required.

***Advertisements for publication should be addressed to:*—Classified Advertisement Dept., "The Engineer", 28 Essex Street, Strand, London, W.C.2.**

Urgent advertisements may be telephoned to CENtral 6565.

PUBLIC APPOINTMENTS

ISLE OF WIGHT COUNTY COUNCIL

ISLE OF WIGHT TECHNICAL COLLEGE

Principal: R. HEWITT, M.Sc., A.F.R.Ae.S., F.R.G.S.

LECTURER

Applications are invited for the post of LECTURER in Production Engineering to Higher National Certificate standard. Applicants should be Graduate or Associate Members of the Institution of Production Engineers and should have had first-class training and subsequent experience in fitting and machine shop work and general production departments. Drawing Office experience, particularly in Jigs and Tools, is also desirable.

Salary in accordance with the Burnham Technical Scales for Lecturers.

Forms of application and particulars may be obtained from the Registrar, Isle of Wight Technical College, Hunnyhill, Newport, Isle of Wight, to whom they should be returned by the 22nd November.

A. L. HUTCHINSON,
E9117 County Education Officer.

COLLEGE OF TECHNOLOGY, BIRMINGHAM

(DESIGNATED COLLEGE OF ADVANCED TECHNOLOGY)

DEPARTMENT OF PRODUCTION ENGINEERING

SENIOR LECTURER

Applications are invited for the post of SENIOR LECTURER.

Salary: Senior Lecturers (Men), £1350 by £50 to £1550. In fixing the commencing salary account may be taken of industrial, professional or research experience up to the maximum of the scale.

Further particulars and forms of application from the Registrar, College of Technology, Gosta Green, Birmingham, 4. Applications to be received within 18 days of this advertisement. Please quote "J."

K. R. PILLING,
E9143 Clerk to the Governing Body.

WILTSHIRE EDUCATION COMMITTEE

NORTH WEST WILTSHIRE AREA COLLEGE OF FURTHER EDUCATION

ASSISTANTS GRADE B

Wanted for January 1st, 1959, or as soon after as possible ASSISTANT GRADE B to teach Mechanical Engineering subjects up to H.N.C. standard. Salary Scale £650 by £25 to £1025 p.a. with allowances for graduation and training.

Assistant Grade B (Graduate) to teach Accounting, Commerce and Economics to G.C.E. Ordinary, National Certificate and Professional students.—Application form and further details from the Principal, Cockebury Road, Chippenham. E9120

SURREY EDUCATION COMMITTEE

RICHMOND INSTITUTE OF FURTHER EDUCATION

KEW ROAD, RICHMOND

QUALIFIED MEN TO TEACH WORKSHOP TECHNOLOGY

Applications are invited from suitably Qualified Men to Teach Workshop Technology, Workshop Practice and Allied Subjects, leading to C. and G. Machine Shop Engineering Intermediate and Craft Practice Final Standard, to part-time day release students.

Burnham Scale for Grade "A" Assistants, plus London allowance and allowance for industrial experience.

Application form, from Principal, to be returned as soon as possible. E9145

PUBLIC APPOINTMENTS

PAISLEY TECHNICAL COLLEGE (CENTRAL INSTITUTION)

MECHANICAL ENGINEERING DEPARTMENT

Applications are invited for two Lectureships in the Mechanical Engineering Department. Candidates should be able to teach to Higher National Diploma and B.Sc.(Eng.) degree level in (a) Mechanical or (b) Production subjects.

Both posts are on the Grade IIa Central Institution scale, £785 to £1350, and require a good honours degree, teaching and research or industrial experience. For post (b) a Higher National Certificate or Diploma in Production Engineering, post-diploma certificates in Production Engineering and good industrial experience may be considered.

In the first instance, applicants should submit a brief summary of their experience and qualifications in writing, or by telephone, to the undersigned.

H. N. HENRY,
Principal.

Paisley Technical College,
28–40, George Street, Paisley. E9134

UNIVERSITY OF KHARTOUM

APPOINTMENTS

Applications are invited for:
CHAIR OF CIVIL ENGINEERING.
SENIOR LECTURESHIP or LECTURESHIP IN MECHANICAL ENGINEERING.
LECTURESHIP IN ENGINEERING MATHEMATICS.
LECTURESHIP IN CIVIL ENGINEERING.
LECTURESHIP IN ELECTRICAL ENGINEERING.

Salary scales: Professor £S.2760 p.a., Senior Lecturer £S.2052–£S.2127 p.a., Lecturer £S.1077 by £S.75 to £S.1977 p.a., entry point according to qualifications and experience. Cost of living allowance approximately £S.180 p.a. Outfit allowance £S.50. Family Allowances: wife—£S.60 p.a., 1st child—£S.90 p.a., 2nd and 3rd child—£S.30 p.a. each. (£S.1 = £1 0s. 6d. sterling). Passages for appointee and family on appointment, termination and annual leave. Initial appointment 5 years with possible renewal. Superannuation Scheme. Unfurnished accommodation provided at rent up to 7½ per cent salary.

Detailed applications (8 copies) naming 3 referees by 29 December, 1958, to Secretary, Inter-University Council for Higher Education Overseas, 29, Woburn Square, London, W.C.1, from whom further particulars may be obtained. E9126

LOUGHBOROUGH COLLEGE OF TECHNOLOGY

DEPARTMENT OF INDUSTRIAL ENGINEERING

LECTURER

Applications are invited for the post of LECTURER in Production Engineering in the Department of Industrial Engineering, at a salary according to the scale £1200 by £30 to £1350 per annum.

Applicants should possess good academic qualifications, and have had industrial and teaching experience in the field of Machine Tool Technology and Tool Design. Experience in Metrology would be an advantage.

The post is pensionable. Commencing salary will be determined by previous experience and qualifications.—Application forms and further particulars may be obtained from the Registrar. (In reply please quote 30/C). E9135

CIVIL SERVICE COMMISSION

CIVIL ENGINEERS

Pensionable posts for men and women aged 25 and under 35 on January 1st, 1958; extension for regular Forces service, Overseas civil service, established civil service, and temporary Government service as Civil Engineer. Candidates must have achieved Corporate Membership of Institution of Civil Engineers or passed examinations necessary for attaining Corporate Membership. Men's starting salary from £755 to £1085. Maximum (London) £1250. Promotion prospects.

Write: Civil Service Commission, 30, Old Burlington Street, London, W.1, for application form, quoting S64/58. E9149

PUBLIC APPOINTMENTS

UNITED KINGDOM ATOMIC ENERGY AUTHORITY, INDUSTRIAL GROUP

HEADQUARTERS, RISLEY, WARRINGTON, LANCASHIRE

CIVIL ENGINEER

CIVIL ENGINEER required by the United Kingdom Atomic Energy Authority, Industrial Group at its Headquarters, Risley, Warrington, Lancashire, to be responsible to a Senior Civil Engineer, for duties associated with experimental, research and chemical establishments. These include design of schemes for the supply, treatment, pumping and distribution of domestic, process and cooling water, for treatment and disposal of normal and trade waste drainage, and for internal building services and roads.

A recognised engineering apprenticeship or pupilage, corporate membership of the Institution of Civil Engineers and experience in the design and construction of at least one section of the duties detailed are essential. Possession of a university degree may be an advantage.

Salary between £1300 and £1740 according to qualifications and experience.

Contributory Pension Scheme.

There is a staff housing scheme.

Send postcard for application form, quoting reference 2738 to Recruitment Officer, at above address.

Closing Date: 24th November, 1958. E9096

MINISTRY OF SUPPLY RESEARCH AND DEVELOPMENT ESTABLISHMENTS

SENIOR SCIENTIFIC OFFICERS AND SCIENTIFIC OFFICERS

Ministry of Supply Research and Development Establishments, mainly in southern half of England, require: (a) SENIOR SCIENTIFIC OFFICERS (minimum age 26), and (b) SCIENTIFIC OFFICERS for work in Physics, Electronics, Electrical or Mechanical Engineering, Applied Mathematics, Aerodynamics, Chemistry or Metallurgy. 1st or 2nd Class Hons. Degree or equivalent required, and for S.S.O. at least 3 years' post-graduate experience. Starting salary in range: (a) £1130–£1330; (b) £595–£1050 (male, in provinces). Rates for women reaching equality in 1961. Superannuation under F.S.S.U. Opportunity for those under 32 to compete for established posts. Candidates should indicate fields of work in which interested. At National Gas Turbine Establishment, Pyestock, Hants, houses available for letting to married staff, and opportunities for new graduates to have workshop training.

Forms from M.L.N.S. Technical and Scientific Register, K, 26, King Street, London, S.W.1 (quote A.300/8A). E8836

DUNMOW RURAL DISTRICT COUNCIL

APPOINTMENT OF
ASSISTANT RESIDENT ENGINEER

Applications are invited for the above appointment on the staff of the Resident Engineer for the construction of sewerage and sewage disposal works under the direction of the Consulting Engineers, J. D. and D. M. Watson, MM.I.C.E., 67, Tufton Street, Westminster, S.W.1. Applicants should be suitably qualified and preferably have some knowledge of sewerage and sewage disposal design.

The salary offered will be between £600 and £800 per annum, according to qualifications and experience. The appointment will be subject to one month's notice on either side and subject to satisfactory service, is expected to last at least a year. Some travelling is likely to be necessary and if the person appointed uses his own car on duty the Council will pay a travelling allowance at a rate not exceeding that payable for a 10 h.p. or 1199 c.c. vehicle in accordance with the National Scheme of Conditions of Service.

Applicants should apply by 1st December, 1958, in writing to the undersigned, giving full particulars of age, qualifications and experience, and enclose copies of not less than two testimonials or the names of two referees.

A. H. BURTON,
Council Offices, Clerk of the Council.
Dunmow,
Essex. E9144

PUBLIC APPOINTMENTS

MINISTRY OF LABOUR AND NATIONAL SERVICE

ROYAL NAVAL SCIENTIFIC SERVICE

APPOINTMENTS

Royal Naval Scientific Service requires SENIOR SCIENTIFIC OFFICERS and SCIENTIFIC OFFICERS for Establishments in London area, Baldock, Portsmouth, Portland, Poole, Greenock and Rosyth. Main requirements are about 25 vacancies for PHYSICISTS, ELECTRONIC ENGINEERS and MATHEMATICIANS in areas specified. The following particular vacancies also exist: MECHANICAL ENGINEER, for work on gas turbine problems in the London area. MECHANICAL ENGINEER for work on design and development of U/W devices in Portland area. METALLURGISTS for Rosyth and Poole. CHEMISTS (Physical and Inorganic), for Poole area, Baldock and London. Candidates must be normally natural born British subjects of natural born British parents, with at least First or Second Class Honours Degrees or equivalent high professional attainments. S.S.O.'s must have had at least three years' post-graduate experience and be not less than 26 years of age. Salaries: (men) S.S.O. £1190–£1410; S.O. £635–£1110 (London)—somewhat lower in provinces. Appointments unestablished (with F.S.S.U. benefits), but opportunities may occur for those between ages of 21 and 32 to compete for established posts.

Forms from M.L.N.S., Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting A98/8A. E8879

BRITISH RAILWAYS RESEARCH DEPARTMENT

SCIENTIFIC OFFICER GRADE I

Vacancy for SCIENTIFIC OFFICER GRADE I in group studying dynamic forces arising during shunting, braking, handling of goods, &c. Must possess necessary mathematical background. Professional and/or academic qualifications essential.

Salary: £1045 to £1150 per annum.
Superannuation and first class travel facilities.
Medical examination.
Applications stating age, qualifications, &c., to:—
Director of Research,
British Transport Commission,
(British Railways Division),
222, Marylebone Road,
London, N.W.1. E9082

THURROCK URBAN DISTRICT COUNCIL

ENGINEER AND SURVEYOR'S DEPARTMENT

ENGINEERING ASSISTANT

Thurrock Urban District Council (Engineer and Surveyor's Department) require ENGINEERING ASSISTANT. Salary within A.P.T. I/II, i.e. £575–£845 per annum. Candidates should have completed their training in a municipal or civil engineer's office, and have had some subsequent experience. Appointment pensionable. Applications, stating age, qualifications and experience, and quoting three referees, to Clerk of the Council, Council Offices, Grays, by 17th November, 1958. Canvassing disqualifies. Relationship with members or senior officer of the Council must be disclosed. E9077

BRITISH TRANSPORT DOCKS

GARSTON DOCKS

NEW WORKS ASSISTANT

British Transport Docks invite applications for appointment as NEW WORKS ASSISTANT on the staff of the Docks Engineer, Garston Docks; salary range £943/985 per annum.

Applicants should have experience in the design, execution and maintenance of dock, harbour, building and permanent way work, and a knowledge of specifications and quantities. Associate Membership of the Institution of Civil Engineers desirable. Travel facilities, superannuation scheme, &c.

Applications, stating age, experience and qualifications, should be sent to the Docks Manager, Garston Docks, Liverpool, 19, to arrive not later than 28th November, 1958. E9151

Classified Advts. continued on page 136

PUBLIC APPOINTMENTS

GHANA PUBLIC SERVICE COMMISSION

GHANA RAILWAY

DEPUTY CHIEF MECHANICAL ENGINEER

Applications are invited for the following vacancy in the Ghana Railway :—

DEPUTY CHIEF MECHANICAL ENGINEER, to assist the Chief Mechanical Engineer in the overhaul control and charge of the Mechanical Engineering Department for the repairs and maintenance of locomotives, carriages, wagons, steam cranes and plant and with the day-to-day operation of locomotives in traffic. The Department consists of four sections, viz.: Workshops, Locomotive Running Section, Carriage and Wagon Section, and the Diesel-Electric Section. Candidates (1) must (a) have passed Parts I, II and III of the examination of the I.M.E., or (b) possess a qualification which is recognised as granting exemption from Parts I, II and III of that examination, and (2) have gained not less than 10 years' post-qualification experience in all aspects of maintenance, manufacture, operation and design of locomotives, carriages and wagons, water supply, electrical equipment on cranes and other auxiliary equipment, and preferably of an age not less than 40 years. Salary £2280–£2400 p.a.

Appointment on contract for two tours each of 18–24 months' duration. Gratuity at rate of £12 10s. for each completed month of residential service, payable on completion of contract. Free first-class passages for officer, wife and up to 3 children under 18 years and, in addition, an education allowance for children when not resident in Ghana of £100 a child for up to 3 children under 18 years. Generous home leave on full pay. Income tax at low local rates. Preservation of superannuation or pension rights, where applicable, can be arranged.

For further particulars and application form write stating age, qualifications and experience, to THE DIRECTOR OF RECRUITMENT, GHANA HIGH COMMISSIONER'S OFFICE, 13, BELGRAVE SQUARE, LONDON, S.W.1. E9147

SHEFFIELD CORPORATION WATERWORKS

APPOINTMENT OF SENIOR TECHNICAL ASSISTANT

Applications are invited for the above appointment (Special Classes Grade £750 by £40 to £1030) on the permanent staff of the Waterworks General Manager and Engineer (J. Noel Wood, M.I.C.E.). Commencing salary according to qualifications, ability and experience.

Applicants must be University Graduates or have passed parts I and II of the examination of the Institution of Civil Engineers and in each case to have had at least five years' experience (including the period spent on theoretical training).

The post is superannuable and the successful applicant will be required to pass a medical examination.

Applications, stating age, education and training, qualifications, present and past appointments (with dates and salaries) and quoting the names and addresses of two referees, should reach the undersigned not later than 22nd November, 1958.

JOHN HEYS,
Town Clerk.
Town Hall,
Sheffield, 1. E9114

HACKNEY HOSPITAL, LONDON, E.9.

(BED COMPLEMENT 982)

APPOINTMENT OF ASSISTANT ENGINEER

Applications are invited for the above appointment, salary £585–£705 p.a. The successful candidate will be required to undertake work connected with the maintenance and operation of the hospital's engineering services (mechanical and electrical) under the supervision of the Senior Engineer. Experience in the operation of oil-fired boilers and possession of the Ordinary National Certificate in Mechanical Engineering or a Ministry of Transport and Civil Aviation 2nd Class Certificate of Competency an advantage. Resident appointment; unfurnished house available (present rental £79 p.a., subject periodic review).

Application forms, obtainable from the Group Secretary, above address, should be returned by 26th November. E9128

PUBLIC APPOINTMENTS

CITY OF BRADFORD

CITY ENGINEER AND SURVEYOR'S DEPARTMENT

APPOINTMENTS

Applications are invited for the following superannuable appointments in the City Engineer and Surveyor's Department :

(a) SENIOR ENGINEERING ASSISTANT (DRAINAGE) Post 202. Grade A.P.T. IV (£1025–£1175).

(b) SENIOR ENGINEERING ASSISTANT (HIGHWAYS) Post 18. Grade A.P.T. IV. (£1025–£1175).

(c) ENGINEERING ASSISTANTS. Posts 119 and 175. Special Grade. (£750–£1030).

(d) JUNIOR ENGINEERING ASSISTANTS. (Posts 63 and 174). A.P.T. I. (£575–£725).

Applicants for Posts (a), (b) and (c) should preferably hold an Engineering Degree, be A.M.I.C.E./A.M.I.Mun.E., and have had for post (a) good general Civil Engineering training with special experience in sewerage and main drainage; and post (b) good general experience in Municipal Engineering with special experience in construction and improvements of Highways.

Applicants for (d) should have completed their professional training and have had general experience in Municipal Engineering.

Applicants should have completed their National Service. No housing accommodation can be provided by the Corporation.

Applications on form to be obtained from City Engineer and Surveyor, Town Hall, Bradford, 1, together with three testimonials must reach me by 28th November, 1958.

W. H. LEATHEM,
Town Clerk.
Town Hall, Bradford, 1. E9098

CIVIL SERVICE COMMISSION

SENIOR SCIENTIFIC OFFICERS (a) SCIENTIFIC OFFICERS (b)

Posts for men and women in all major scientific fields, including physics, chemistry, biology, meteorology, mathematics. Specially needed are :

PHYSICISTS, for research in physical oceanography; determination of atomic constants from nuclear magnetic resonance, &c.

PHYSICIST - MATHEMATICIAN, for Civil Defence problems.

GEOPHYSICIST (frequent overseas surveys).

CHEMISTS, for research in organic biochemistry for plant protection; reaction kinetics; radiation chemistry; modern analytical techniques (especially spectrography and chromatography); chemical engineering.

BIOLOGISTS, for taxonomy of invertebrate animals; fungus systematics; plant pathology; taxonomic botany (Pteridophyta); taxonomic botany (orchidaceae); microbiology.

ENGINEERS, for research on road construction and traffic flow; wind pressures on buildings; application of servo-control to machine tools.

HEALTH PHYSICIST (and Radio Chemical Inspector).

Qualifications : normally First or Second Class Honours Degree in Science, Mathematics or Engineering, or equivalent attainment; additionally, for (a) at least 3 years' relevant (e.g. post-graduate) experience. Normal age limits; (a) between 26 and 31, (b) between 21 and 28, with extension for regular Forces service and Overseas Civil Service. London salaries (men) : (a) £1190–£1410, (b) £635–£1110. Five-day week generally.—Write, Civil Service Commission, 30, Old Burlington Street, London, W.1, for application form, quoting (a) S.53/58, (b) S.52/58. E9148

WEST KENT MAIN SEWERAGE BOARD

SENIOR ENGINEERING ASSISTANT

SENIOR ENGINEERING ASSISTANT (£780–£1060). (Special grade with London allowance.) Commencing salary according to ability. N.J.C. conditions of service. Local government superannuation. Qualifications : University degree in engineering or graduate membership of I.C.E. Work includes design of sewers and reinforced concrete structures.—Applications, giving full personal details, particulars of education, training and experience and the names and addresses of two referees, should reach me within ten days of the publication of this advertisement.

A. J. W. JEFFERY,
Secretary of the Board.
20, Blyth Road,
Bromley, Kent. E9110

PUBLIC APPOINTMENTS

ATOMIC ENERGY RESEARCH ESTABLISHMENT

HARWELL

An apprenticed or similarly trained

TECHNICAL OFFICER

is required to assist a senior engineer in the preparation of cost estimates of mechanical and electrical components from engineering drawings. The post involves liaison with scientists and engineers.

Engineering "know how" and an acceptable personality are as important as estimating experience.

Salary : £1050–£1270 (Technical I).

Housing and superannuation schemes.

Please send a POSTCARD to the Group Recruitment Officer (1266/25), U.K.A.E.A., A.E.R.E., Harwell, Berks., for details.

E9094

TENDERS

INDIA SUPPLY MISSION

SUPPLY OF PLANT AND MACHINERY

TENDER NOTICE

TENDERS are invited by the India Supply Mission, 2536, Massachusetts Avenue, N.W. Washington, D.C., for the SUPPLY OF PLANT AND MACHINERY as listed below for the Locomotive Component Works, Mandundih, Varanasi, India. Tender forms containing Instructions to Tenderers, Conditions of Contract and Offer form, priced at $10.00 (£3 11s. 6d.) per set and specifications for the Plant and Machinery priced at $4.00 (£1 8s. 6d.) per each item separately as shown below can be obtained from the above office/Dir. General, India Store Dept., Co-ordination Branch, Government Bldg., Bromyard Avenue, Acton, London, W.3, England/Embassy of India, Naigai Bldg., 5th Floor, No. 13/20 Chome Marunouchi, Chiyodaku, Tokyo, Japan/Indian Trade Commissioner in Australia, Caltex House, 167–187, Kent St., Sydney, Australia/Dir. General of Supplies and Disposals, Shahjahan Road, New Delhi, India. When applying for tender papers, please state for which items the specifications are required, and enclose the total amount accordingly. Quote reference Tender No. SE-11. Tender closing date December 23, 1958.

Item No.	Nomenclature :
1	Lathes, Brass Finishers', Copying, and Boring and Turning.
2	Heavy Duty Lathe, Capstans and Turrets.
3	Tracer Controlled and Plane Millers, Key Seating Machines.
4	Slotting and Planing Machines.
5	Drilling Machines.
6	Grinding Machines.
7	Horizontal, Jig and Locomotive Axle Box Borers, Heavy Vertical Duplex Borer.
8	Metal Cutting Cold Circular Saws; Horizontal and Vertical Band Saws.
9	Furnaces Billet Heating, Spring Making and Heat Treating.
10	Nil.
11	Press Forcing, Trimming, Spring Scragging and Buckling.
12	Power Hammers, Drop Stamps, Double Acting Hammers and Forging Machine.
13	Wood Working Machines.
14	Foundry Sand Preparing Equipment, Sand Slingers.
15	Miscellaneous Foundry Equipment, e.g. Shot Blasting, Centrifugal Casting, Core Blowing, Magnetic Separator, &c.
16	Butt Welding, Oxy-Acetylene Cutting and Brazing Machines.
17	Punching, Shearing and Spring Plate Forming Machines.
18	Instruments and Testing Machines.
19	Weighing Machines.
20	Sundry Machines, e.g. Bar Reeling, Screwing, Chain Testing, Centring, &c.
21	Handling equipment, viz. Auto and Fork Lift Trucks.
22	Air Compressors, Pumps, Fire Pump and Sprinkler, Vacumm Cleaner.

E9127

SOUTHAMPTON CORPORATION WATERWORKS

SWAYTHLING BOOSTER STATION

CONTRACT NO. 1

TENDERS are invited from manufacturers of centrifugal pumps for the SUPPLY and ERECTION of TWO SETS of Electrically Driven SUPPLY PUMPS, complete with A.C. Motors and other Equipment. (Maximum duty of each set 14,000,000 gallons per day against 90ft. head.)

Specification and conditions may be obtained from the Waterworks Engineer and Manager, Civic Centre, Southampton. Tenders to be submitted to the Town Clerk, Civic Centre, Southampton, by Monday, 15th December, 1958. E9076

TENDERS

COUNTY OF CORNWALL

LOOE BRIDGE, LOOE, CORNWALL

WIDENING

TENDERS are invited from experienced Contractors for the WIDENING of the above Bridge. This involves :

(1) The construction of six River Piers.

(2) The Construction of Abutments.

(3) The Construction of Precast Concrete Arches.

(4) Stone Facing Work.

(5) Chemical Consolidation of River Bed.

Copies of the contract documents may be obtained from the Consulting Engineers, Messrs. Mott, Hay and Anderson, 9, Iddesleigh House, Caxton Street, Westminster, London, S.W.1, on payment of a deposit of £30 by cheque made payable to the Cornwall County Council. The deposit will be repayable when a bona fide tender has been received.

Tenders in envelopes clearly endorsed "Tender for Looe Bridge Widening," but not bearing any name or mark indicating the sender, should be addressed to the undersigned, Room 3, County Hall, Truro, and must be delivered not later than 2 p.m. on Friday, the 19th December, 1958.

The Council do not bind themselves to accept the lowest or any tender.

E. T. VERGER,
Clerk of the County Council.
County Hall,
Truro.
30th October, 1958. E9103

EDUCATIONAL

TECHNICAL HOME STUDY COURSES

For A.M.I.Mech.E., A.M.I.Chem.E., A.M.I.M.I., A.F.R.Ae.S., C.& G., &c.

OVER 50 FIRST PLACES and more than 2000 Passes have been secured by T.I.G.B. Students at Professional Engineering Examinations. We have a wide range of exclusive Home Study Courses in all branches of Engineering—Mechanical, Electrical, Aeronautical, Automobile, Chemical, Gas, Radio, and Television, Draughtsmanship, &c. Textbooks, blueprints, &c., are provided and, if desired, fees may be paid by moderate instalments.—Write (stating subject of interest) for copy of 110-page Prospectus FREE and without obligation.

THE TECHNOLOGICAL INSTITUTE OF GREAT BRITAIN

(Dept. 76),
29, WRIGHT'S LANE, LONDON, W.8.
E102 E

A.M.I.MECH.E., B.Sc., City and Guilds, &c. Guarantee Postal Courses for all Exams., and Technical Divisions from Elementary to Degree standard including Automation Techniques. Approximately 95 per cent. successes. 148-page prospectus free on request.—B.I.E.T. (Dept. 22), 29, Wright's Lane, London, W.8. E114 E

SITUATIONS VACANT

APPLICANTS ARE ADVISED TO SEND COPIES, NOT ORIGINALS, OF THEIR TESTIMONIALS UNLESS OTHERWISE REQUESTED.

AERO THERMO-DYNAMICIST, with experience of gas turbine design, preferably from aircraft industry. DESIGNER-DRAFTSMAN, preferably with gas turbine experience. DEVELOPMENT ENGINEER AND ASSISTANT TO MANAGING DIRECTOR, with gas turbine experience, alternatively ex-Service Engineer Officer. The above vacancies are for permanent positions where intelligence and initiative will be rewarded. Apply with full details.—BOX No. E9120, "The Engineer." A

CHIEF ENGINEER

Chief Engineer required for medium-size engineering company in London. Responsible to the Directors for the design, engineering, development and testing of the company's products. B.Sc. Degree desirable, but this requirement may be waived if the applicant's general education and experience is considered suitable. Experience in automotive transmission and axle design, gears, aircraft gear drives, &c., including the testing of such products. Good salary and prospects, age 35/45 years approx., superannuation scheme.—Write full details, including appointments held and present salary, in strict confidence, to BOX B.262, c/o Streets, 110, Old Broad Street, E.C.2. E9118 A

DRAUGHTSMEN.—Senior Engineering Draughtsmen required in our works plant engineering and maintenance department. Applicants, aged 28 or over, should hold H.N.C. or equivalent in one of the following :—

Mechanical.

Electrical.

Building.

Apprenticeship and 5 years' subsequent workshop experience desirable, plus originality and flare for design.—Write in confidence, with full details, to Siemens Edison Swan, Ltd., Ref. 744/33, Woolwich, London, S.E.18. E8857 A

ENGINEER (MAIN GRADE)

required by

THE ATOMIC WEAPONS RESEARCH ESTABLISHMENT, ALDERMASTON, BERKS.,

to assess the mechanical engineering requirements necessary to meet a tight production schedule; to integrate the production requirements of several divisions into a co-ordinated programme and to make a quick and reliable forecast of requirements from limited information.

A recognised engineering apprenticeship and a wide experience in all aspects of production required. Corporate Membership of the Institution of Mechanical Engineers is essential.

SALARY : £1300–£1740.

Contributory Superannuation Scheme. A house or, alternatively, substantial assistance in house purchase, will become available for married officers living beyond daily travelling distance.

POSTCARDS for application forms to the Senior Recruitment Officer at above address. Please quote ref. A.1939/25.

E9095

SITUATIONS VACANT

COLVILLES LIMITED
have openings for first-class DESIGN DRAUGHTSMEN. Steelworks experience not strictly essential if applicant is otherwise fully qualified and adaptable.

Apply by letter to C.M.E. Department, Technical Offices, Motherwell, stating experience and technical qualifications.

E9051 A

DESIGN DRAUGHTSMAN required by Company engaged in manufacture of Civil Engineering equipment. Applicants should preferably have experience in Asphalt Plants ; 5-day week, pension scheme.

Apply in writing, giving full details of education, qualifications, age and experience, to :
BARBER-GREENE OLDING AND CO., LTD.,
HATFIELD,
HERTS.

E9032 A

SITUATIONS VACANT

ELECTRONICS ENGINEER

COURTAULDS, LTD., require a SENIOR ELECTRONICS ENGINEER for the Experimental Department of their Engineering Division in Coventry. Applicants should possess a degree or equivalent academic qualification and should have had several years' industrial or research experience. The appointment is pensionable and will qualify for Co-partnership benefits.

Candidates should write for a detailed form of application to the Director of Personnel, Courtaulds, Ltd., 16, St. Martins-le-Grand, London, E.C.1, quoting reference number B.50.

E9101 A

ENGINEER, Graduate or Diplomas, in late twenties, with some experience in structural drawing-office, and construction work, required for service with well-known Indian company of bridge builders in Calcutta. Good prospects for the right candidate. —Apply, giving details of qualifications, experience, age, health, when available, &c., to the Secretary, Braithwaite and Co., Engineers, Limited, "The Moorings," Church Road, Great Bookham, Surrey. E9119 A

BOOKS and PUBLICATIONS

INDUSTRIAL LAW
By H. Samuels, M.A. 5th Edition. A book that is renowned as a clear-cut and concise guide to the complexities of industrial law and the intricacies of industrial relations. New and up-to-date edition. 21/- net.

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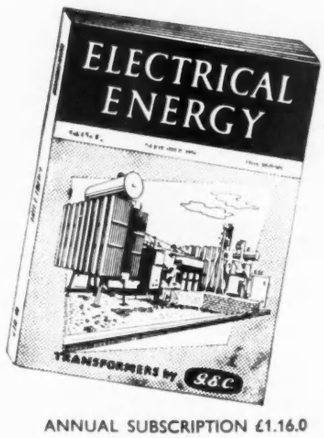

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SITUATIONS VACANT

DESIGN DRAUGHTSMEN required for mechanical design of nucleonic instruments. Pleasant working conditions. Excellent rates of pay.—Apply Chief Draughtsman, Isotope Developments, Ltd., Beenham Grange, Aldermaston, Berks. Tel.: Woolhampton 451. E9116 A

EDITORIAL POST.—Young Engineer, qualified to become Corporate Member Major Engineering Institution, required to fill Editorial Post covering light electrical and electronic engineering. Desire to write essential. Age 26 to 30 preferred. Pension and bonus schemes.—Reply, stating age, particulars of qualifications and experience to date, to The Editor, "The Engineer," 28, Essex Street, London, W.C.2. E9158 A

ENGINEER (MECHANICAL).—Applications are invited from Engineers not over 35 years, who possess First Class M.O.T. Certificates (Steam). Willing to reside in or near London for duties in that area and to undertake three-monthly tours of inspections of boilers, pressure vessels, &c., in West Africa. Salary in accordance with age, previous experience, if any, plus expenses and allowances. Non-contributory pension scheme. Apply in own handwriting.—BOX No. E9056, "The Engineer." A

ENGINEER (Non-Resident), by Middlesex County Council, for Percy House, Isleworth, Middlesex (large home for aged). Required to take charge of and be responsible for, operation and maintenance of engineering installations, comprising Calloway and Cornish boilers, calorifiers, steam-driven circulating pumps, steam meter, &c., and usual central heating and domestic hot and cold water systems, steam cooking equipment, electric passenger lifts, power, lighting and sundry other installations. Should be conversant with installations to above and experienced in maintenance of same. Salary £655–£715 p.a.; 44-hour week. Established, pensionable subject to medical assessment.—Apply, giving full particulars and 3 referees, to Chief Welfare Officer, I, Queen Anne's Gate Buildings, Dartmouth Street, S.W.1. Canvassing disqualifies. E9150 A

EXPERIENCED HEATING AND VENTILATING ENGINEER required by contractors in Westminster. Applicants must be experienced in the preparation of drawings and estimates. Non-contributory pension scheme.—Apply, in confidence, to Managing Director, J. B. JACKSON AND PARTNERS, LTD., 167, Millbank, S.W.1. 'Phone : Victoria 3933. E2189 A

FIRST CLASS DRAUGHTSMAN required East Anglia. Experienced General Engineering and Mechanical Handling. Good technical training and able to work with minimum supervision. Flat available if required. First class conditions. Superannuation.—Apply, stating age, experience and salary required to Technical Director, BOX No. E9142, "The Engineer." A

FORENSIC ENGINEERS invite application from ENGINEERING GRADUATES with good background and industrial experience, for responsible and individualistic post. Age about 30 years.—BOX No. E9140, "The Engineer." A

GOSS PRINTING PRESS COMPANY, LTD., have an immediate vacancy for a SENIOR DRAUGHTSMAN with experience in the design of machine tools. This is a permanent position with a generous superannuation scheme and a bonus is paid annually. Salary paid will be in accordance with ability and experience.—Please supply full details of age, experience and qualifications, to Personnel Manager, Greenbank Street, Preston. E9153 A

HUDSWELL, CLARKE AND CO., LTD.,
require a
TECHNICAL WRITER
for the preparation of specifications, maintenance manuals and sales literature for mechanical handling equipment, and special-purpose machines. Applicants must be able to write clearly and concisely on technical subjects, and have some mechanical engineering training. The appointment is permanent and pensionable.

Apply in writing, stating age, qualifications and salary required, to The Chief Designer, Hudswell, Clarke and Co., Ltd., Olympia Works, Roundhay Road, Leeds, 8.

E9159 A

JIG AND TOOL DESIGNER to take charge of small Drawing-Office, preferably with Mould Design and Estimating experience, over 30 years of age, required immediately. Permanent and progressive position, very good salary (according to qualifications and experience), non-contributory pension scheme.—Apply with full details in confidence, stating fully training and positions held, to the Managing Director, Ferrostatics, Ltd., Borough Works, Glossop, Near Manchester. E2184 A

LARGE OIL COMPANY
requires
CIVIL ENGINEER
for work in Persian Gulf area. Applicants should hold A.M.I.C.E. or be exempt from Parts A and B of the Associate Membership examination and have some years' experience with consulting engineer or contractor. They must be prepared to live in remote construction camps and under canvas if necessary. Three-year (renewable) contracts with gross pay over £2000 per annum. No income tax at present.—Bachelors between 25 and 35 should write in detail, quoting No. 865, to BOX No. 2078, c/o Charles Barker and Sons, Ltd., Gateway House, London, E.C.4.

E9161 A

LADY TRACER required on civil engineering work in Westminster. Neatness, accuracy and speed more essential than age range.—Details of experience &c. please to BOX No. E9111, "The Engineer." A

SITUATIONS VACANT

JUNIOR ASSISTANT MECHANICAL ENGINEER OR DRAUGHTSMAN wanted immediately. Must have good education, at least H.N.C. standard in Engineering, sound practical apprenticeship of not less than two years in engineering works, and preferably a year or so in a modern drawing-office. Experience on pumps, pipework, vessels and other chemical plant an advantage. Age preferably 24 to 28. Starting salary in range £600 to £900. Candidates on short list will be asked to attend for interview at Dublin, all expenses paid.—Please give full chronological particulars of education, training and posts held, to The Chief Engineer, ARTHUR GUINNESS SON AND CO. (DUBLIN), LTD., St. James's Gate, Dublin. E9157 A

MECHANICAL TRANSMISSION ENGINEERS

Two new vacancies with excellent prospects have arisen in an expanding engineering company situated in South-east London, for work on world-famous high-powered hydro-mechanical transmissions. A.M.I.Mech.E. is essential for one post, but candidates with H.N.C. will be considered for the second, especially if they have suitable experience. Age preferably 25 to 40 years. Experience of transmission or application engineering desirable and knowledge of German helpful but not essential.

Duties will include application engineering, design, testing and operating problems.

Please write, giving full details of qualifications and experience, to Personnel Manager, BOX MT 194, A.K. Advg., 212a, Shaftesbury Ave., W.C.2.

E9136 A

OPERATING ENGINEERS for high-pressure water tube boilers required by well-known firm of Boiler Contractors. Applicants must have previous experience and be prepared to travel anywhere in the U.K. Minimum qualifications B.O.T. Certificate (Steam). Membership Institute of Marine Engineers of H.N.C. an advantage. Salary commensurate with experience and qualifications. Pension Scheme. Apply, giving full details of age, previous employment and qualifications in confidence.—BOX No. E8967, "The Engineer." A

PILKINGTON BROTHERS, LTD.,
require an
ELECTRICAL ENGINEER
to take charge of the power frequency section of a large High Voltage Laboratory. Voltages up to 1300kV are available. An extensive programme of research and development is in progress.

A University degree is required, with preferably some experience of high voltage laboratory work. The preferred age range is 25–30.

Applications stating age, qualifications, experience and present salary, should be addressed to :

Personnel Officer (Graduate Recruitment), Pilkington Brothers, Limited, St. Helens, Lancs.

E9102 A

PLANT ENGINEER
is sought by international chemical company with expanding production facilities in the U.K. Candidates, preferably with corporate membership of the Institution of Mechanical Engineers, or equivalent, should have experience both in chemical plant maintenance and the design and construction supervision of new plant, and should be capable of working with minimal supervision. The vacancy offers splendid scope for a genuinely practical man, and carries an appropriate salary and benefits of insurance and pension schemes ; it will be based on works at Erith, Kent, with a secondary interest in an additional works in Lancashire.—Please write with full details of qualifications, experience and age, in confidence, to BOX 852, Reynell's, 44, Chancery Lane, W.C.2.

E9100 A

PRODUCTION ENGINEER, with practical, technical and commercial experience, required by North London Engineering Company.—Reply, giving full particulars, to BOX No. E9160, "The Engineer." A

REORGANISATION OF TECHNICAL SALES requires the appointment of a SALES REPRESENTATIVE with first-class technical knowledge and considerable experience in the selling of heavy Marine Diesel Engines.—Write, giving all details, age and salary required, to BOX No. E8743 "The Engineer." A

STEWARTS AND LLOYDS, LTD.
STEEL FOUNDRY REPRESENTATIVE
Applications are invited for a vacancy as a REPRESENTATIVE, covering area Birmingham and Southern England, for the Steel Foundry of the above firm. Essentials are a sound knowledge of steel foundry practice and experience in this type of representation. The successful applicant would be required to live in the Birmingham area.—Letters should be sent addressed to The Manager, Personnel Services, Clyde Tube Works, Coatbridge, Lanarkshire, Scotland.

E9099 A

Classified Advts. continued on page 138

SITUATIONS VACANT

SENIOR SCIENTIFIC INVESTIGATOR urgently needed for the INTERNATIONAL FLAME RESEARCH project at Ijmuiden, in Holland, with the likelihood of becoming Principal Investigator to the project in two years' time. A Graduate Physicist, Chemist, Chemical Engineer, Fuel Technologist, or Mechanical Engineer, with post-graduate research experience equivalent to a Ph.D. and at least some knowledge of the problems of either measurements in large industrial flames or the laws of soot formation, luminous radiation and heat transfer from flames. A house or flat can be found close to the Royal Dutch Steelworks at Ijmuiden, the cost of moving to Holland would be paid, and salary in the range £1900 to £1500 per year. This position offers a very attractive possibility to a man wishing to establish an international reputation in the field of large flame problems.—Written applications should be sent to Professor M. W. Thring, University of Sheffield, St. George's Square, Sheffield, 1. E9113 A

SUCCESSOR SOUGHT TO RETIRING MANAGING DIRECTOR, of sound self-contained engineering firm near Leeds, now employing 200 in all, and designing, manufacturing, selling and servicing its own light to medium precision products in the United Kingdom. There are some immediate problems requiring experienced handling, and applications will only be considered from men having overall management experience in self-contained businesses. Remuneration is by salary and commission on profits. In their replies, applicants should state their present earnings and indicate what they consider to be their strong points.—BOX No. E2176, "The Engineer." A

TECHNICAL EDITOR required by rapidly expanding organisation in the East Midlands, for new group of journals covering many aspects of production and mechanical engineering. This appointment carries an excellent starting salary and offers considerable scope for development to a man with ability and energy. Superannuation scheme and pleasant surroundings. Send details of career and present salary.—BOX No. E9133, "The Engineer." A

TECHNICAL REPRESENTATIVE in connection with hire of large cranes and associated services. Some heavy mechanical engineering experience, including drawing-office work and a successful period as salesman or technical representative in similar work essential. Salary plus commission to commence, not less £900, with ample opportunity for improvement.—BOX No. E9054, "The Engineer." A

TECHNICAL SALESMAN required, to cover London area and South of England, for sales of modern oil-fired steam-raising units with electronic controls. Desirable qualifications include good technical education, some electrical knowledge, experience of packaged boilers or steam generators and connections with users of such equipment. Contributory superannuation scheme.—Apply in confidence, stating age, qualifications, experience and remuneration expected, to the Secretary, The Vulcan Foundry, Limited, Newton-le-Willows, Lancashire. E9115 A

TRANSLATOR REQUIRED for translation of Russian technical periodicals, books, &c. Sound knowledge of mechanical or production engineering. This is a key position in a rapidly expanding organisation in the East Midlands. Excellent prospects of advancement, working conditions, and superannuation scheme.—Send full details to the Secretary, PRODUCTION ENGINEERING RESEARCH ASSOCIATION, Melton Mowbray, Leics. E9066 A

WORKS ENGINEER required by a large drop forging organisation, employing very heavy equipment. Applicant must be fully qualified and experienced in the maintenance and efficiency of all plant and services engaged in the hot working of steels.—Details of experience, &c., to the Works Director, SMITH-CLAYTON FORGE, LTD., Lincoln. E2175 A

WORKSHOPS MANAGER required by the National Coal Board for their Central Workshops at Shotts, Lanarkshire. Salary, according to qualifications and experience, within the range £1050–£1600 per annum. The workshops which employ 200 personnel, are mainly engaged on the large-scale overhaul and repair of electrical and mechanical plant and machinery associated with coal-mining. Candidates should be experienced in modern methods of planned overhaul of plant and capable of organising workshops.—Applications, stating age, education, qualifications, experience, present post and salary, to the Divisional Chief Staff Officer, National Coal Board, 3, Eglinton Crescent, Edinburgh, 12. E9132 A

SITUATIONS VACANT

CARBIDE INDUSTRIES LIMITED

MECHANICAL ENGINEERS

are required to assist in the design and development of an interesting project in the heavy chemical field. A sound technical background is essential. Some experience is required in one or more of the following aspects :—

Chemical plant layout, plant and process design, mechanical handling, process control, liaison with suppliers and contractors, maintenance and spares.

These are progressive and pensionable positions and a good commencing salary will be paid.

Apply in writing to :

The Staff Officer,
BRITISH OXYGEN COMPANY LTD.,
Bridgewater House,
Cleveland Row, St. James's, S.W.1.

E9146 A

GENERAL ELECTRIC COMPANY LIMITED
ATOMIC ENERGY DIVISION

CIVIL, MECHANICAL AND ELECTRICAL SENIOR SITE ENGINEERS

Applications are invited from Engineers to supervise the construction of Atomic Power Stations.

Applicants should have had previous experience on large construction projects and a Degree or Membership of one of the Senior Institutions is desirable.

These positions, which are permanent and pensionable, give opportunity to those able and willing, for consideration for posts of high responsibility and appropriate remuneration.

Application, giving full details of qualifications and experience, should be made to : Personnel Manager (D.W.T.A.),

THE GENERAL ELECTRIC CO., LTD.,
FRASER AND CHALMERS ENGINEERING WORKS, ERITH, KENT.

E9074 A

GENERAL DESIGN DRAUGHTSMAN

for

BAHRAIN

APPLICATIONS are invited for this position with the Bahrain Petroleum Company, Limited, from men with Higher National Certificate in Mechanical Engineering and not over 35 years of age.

Duties involve necessary design calculations for work such as positioning and sizing expansion loops in process lines, sizing of structural members for support structures, calculating stresses in pressure vessels to determine allowable wall thicknesses, &c., and applicants must have a thorough knowledge of First and Third Angle and Isometric projection drawings, and of materials and methods of construction.

The commencing salary is £111.0.0. per month, in addition to which free air-conditioned accommodation and a living allowance are provided. An initial kit allowance, medical attention, paid local and home leaves are also provided with participation in Pension and Provident Fund Schemes.—Apply in writing, quoting "ETS," with full particulars of experience, to Caltex Services, Limited, Caltex House, Knightsbridge Green, London, S.W.1.

E9105 A

SITUATIONS VACANT

Richard Thomas & Baldwins Ltd.

are seeking an

ASSISTANT MECHANICAL ENGINEER

for their

Ebbw Vale Section

Candidates should be under 30 years of age. A degree in engineering (or its equivalent) and practical apprenticeship are essential qualifications. The position offers good opportunities to an energetic young man with initiative, interested in the wide variety of machinery employed in the steel industry. Previous steelworks experience is not essential for the right type of man.

Salary commensurate with qualifications ; superannuation scheme.

Applications will be treated as strictly confidential, and should be addressed to the

Chief Engineer,
Richard Thomas & Baldwins Limited,
Ebbw Vale, Mon.

E9156 A

SITUATIONS VACANT

THE DE HAVILLAND ENGINE COMPANY, LIMITED

invites applications from experienced

PERFORMANCE ENGINEERS

for interesting work on basic design and estimation of performance associated with Aero and Industrial Gas Turbines ; Axial and Centrifugal Compressors ; Turbo Supercharging, &c.

Applicants should be of Degree or Higher National Certificate standard, but appropriate experience in the field of Air Compressors, Steam or Gas Turbine design will be regarded as of equal importance.

Write in full, giving experience and particulars of qualifications, and quoting reference SC 793, to :

The Personnel Officer,
THE DE HAVILLAND ENGINE COMPANY, LIMITED,
Stag Lane, EDGWARE, Middlesex.

E9093 A

ASSISTANT STEAM SERVICES ENGINEER

Owing to expansion within the Company, an Assistant Steam Services Engineer is required by the Steel Company of Wales Limited (Steel Division), in their Power Plant Department.

Applicants must be thoroughly experienced with all aspects of low pressure boiler operation, and have some knowledge of steam distribution systems. Their duties will also include technical investigations, plant testing and the direct supervision of extensive operation and maintenance sections.

Candidates must be able to produce evidence of an advanced technical education.

Those wishing to apply should write, giving full details of age, experience, present salary and any further information considered relevant, to :—

Superintendent, Personnel Services,
THE STEEL COMPANY OF WALES, LIMITED
(Steel Division)
Abbey Works, Port Talbot

E9122 A

J. STONE & COMPANY (CHARLTON) LIMITED

Experienced Foundry Technologists are invited to apply for new and progressive openings in senior executive grades which are being created in one of the finest non-ferrous founding companies in the country.

The positions will concern either technical control, manufacturing methods, estimating or production control.

Applications (which will be considered together with those from our existing staff) will be treated in strict confidence and should give full details of education, technical qualifications, career, positions held and salaries earned ; Candidates should also state what knowledge they possess of any or all of the following :—light alloy castings, bronze castings, precision castings, and general production engineering.

Envelopes should be marked **"PRIVATE AND CONFIDENTIAL"** and addressed to :—

WORKS DIRECTOR (GENERAL FOUNDRIES),
J. STONE & COMPANY (CHARLTON) LIMITED
WOOLWICH ROAD,
CHARLTON,
LONDON,
S.E.7.

E9125 A

HEAT TRANSFER ENGINEER

THE ENGLISH ELECTRIC CO., LTD.

has a vacancy in its

MECHANICAL ENGINEERING LABORATORY

at Whetstone, Nr. Leicester,

for an engineer who believes he can contribute to fundamental research on Heat Exchange.

The successful candidate will probably have several years' practical experience of the design and testing of heat exchangers, together with sufficient theoretical knowledge of heat transfer and fluid dynamics to be able to temper tradition with considerable originality. He will be primarily responsible for carrying through a programme of heat exchanger tests using a large wind tunnel test facility in course of construction, but will also join in other research activities of a young, enthusiastic team in the fields of heat transfer and thermodynamics.

Applications, giving details of education, qualifications and experience, should be sent to : Dept. C.P.S., English Electric Co. Ltd., Strand, London, W.C.2, quoting reference E1917D.

E9106 A

SITUATIONS VACANT

DESIGNERS AND ENGINEERS

with extensive experience on Bulk Material Handling Plant and Equipment, required by well-known progressive Company in the Midlands serving Coal, Quarry, Oil, Gas and Chemical industries. Work will involve preparing Project Arrangement drawings, specifications and quantity estimates and ultimately following these through the Production Drawing Office.

The men we are looking for will be first and foremost Structural Designers used to Stress work, coupled with familiarity with designs of Crushing, Screening, Conveying and Bulk Handling of Materials and Fluids. They will be at least H.N.C. standard, will have initiative and already be earning in the region of £1000.

Applicants with proved ability will be invited for early interview for which expenses will be paid.—Write, giving full chronological details of experience, &c., to BOX No. E9109, "The Engineer."

A

ELECTRICAL ENGINEER

wanted by leading German manufacturer for German-English translations. Applications are invited from British-trained engineers with a good general education and sound technical training, preferably also with practical experience in the application of electric equipment. Good working knowledge of German is essential. The ability to write clearly and concisely will be expected of candidates. A five-day week is worked with generous holidays. Favourable housing conditions for permanent staff.—Apply, stating age, education, qualifications, experience and salary required, to BOX No. E9064, "The Engineer."

A

GENERAL SALES MANAGER

A prosperous and progressive engineering concern in the North of England, engaged in the manufacture of specialised machinery, invite applications for the position of General Sales Manager from persons possessing successful records of top-level sales administration in the engineering field. Necessary qualifications are a high standard of education, an engineering background—preferably with an Engineering Degree—outstanding organising ability and a flair for selling. This is an important senior post of interest only to men who are capable of taking complete control of the sales activities of a go-ahead Company and promotion to the Board is envisaged for the man whose achievements justify such an appointment. Replies should include comprehensive details of age, experience, qualifications, present salary and salary required.—BOX No. E9130, "The Engineer."

A

A vacancy occurs in a Birmingham firm for a

DEVELOPMENT ENGINEER

between 25 and 55 years old, possessing a degree or Higher National Certificate in Mechanical Engineering, and capable of working with a minimum of supervision. Salary £800 to £1000, non-contributory pension and profit sharing schemes. For further information please contact :

Birmingham Productivity Association Technical Advisory Service Limited, 95, New Street, Birmingham, 2, quoting ref. 453/DE. TEL.: MID 0912.

E9028 A

SENIOR DESIGN DRAUGHTSMEN

required by

ENGLISH ELECTRIC
RUGBY

for their Steam Turbine Drawing Office. Applicants should be of H.N.C. standard, have served a recognised apprenticeship in heavy engineering, and have experience of heavy mechanical design associated with power generation plant. Details of housing assistance will be discussed at interview.

Please write, giving full details, to Dept. C.P.S., Marconi House, The Strand, London. W.C.2, quoting reference E1199M.

E9107 A

EXECUTIVE ENGINEER

A prosperous and progressive engineering concern in the North of England, engaged in the manufacture of specialised machinery, invite applications for the position of Executive Engineer to take complete charge of process planning, ratefixing, jig and tool and manufacturing methods departments. Candidates must have a wide knowledge of methods and industrial engineering, and will be expected to have had experience in works management. This is a top-level appointment which offers exeellent opportunities for advancement in a go-ahead Company, and a generous salary will be paid to the right man. Please give full details of age, experience, qualifications and present salary. —BOX No. E9131, "The Engineer."

A

SITUATIONS WANTED

MANAGEMENT EXECUTIVE (42), experienced control all departments light-medium engineering, A.M.I.Mech.E., A.M.I.Prod.E., seeks Responsible High-Level Management Post, London or South.—BOX No. E2181, "The Engineer."

B

GENTLEMAN (45), wide experience as Liaison Engineer on contracts and development, based London, willing act for Northern firms in Greater London and Continent. Government contacts.—BOX No. E2182, "The Engineer."

B

SUPERINTENDENT ENGINEER (48) seeks responsible position, experienced maintenance, installations, contracts and building fabrics. Conscientious, willing and reliable. Present salary £975. Any locality.—BOX No. E2183, "The Engineer."

B

SALES ENGINEER (32), N.C. Mech., A.M.I.B.F., A.M.I.H.V.E., 8 years' practical engineering experience, 7 years' sales and administrative, home and export, fluent Italian, some French and German.—BOX No. E2188, "The Engineer."

B

FOR HIRE

LATTICE STEEL. Erection Masts (light and heavy), 30ft. to 150ft. high, for immediate hire.—Bellman's, 21, Hobart House, Grosvenor Place, S.W.1. ('Phone SLOane 5259). E103 K

HIRE A £1500 CAMERA FOR ONLY £5. All other types of photographic equipment available.—B. Bennett and Sons, Ltd., 25/27, Oxford Street, London, W.1 (Telephone, GERrard 9953). Catalogue on request. E128 K

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CASTINGS.—We can save your porous castings, ferrous or non-ferrous, by an approved impregnation process ; sample castings treated ; A.I.D. approved. —Recupero, Ltd., 66, South Harrow Viaduct, Harrow, Middlesex ('Phone, Byron 1178). E109 MW

KELLERING AND CAM PROFILING capacity up to 8ft. by 6ft. or 6ft. diameter.—ARMYTAGE BROS. (KNOTTINGLEY), Ltd., The Foundry, Knottingley, Yorkshire (Telephone : Knottingley 2743/4). E116 MW

PRATCHITT BROTHERS, LTD., Denton Iron Works, Carlisle, having well-equipped engineering shops and ironfoundry, invite enquiries for General Engineering, Structural and Platework, from firms wishing to have plant made to their own designs and specifications. E751 MW

BUSINESS OPPORTUNITIES

FOR SALE, Controlling Interest Small Heat Treatment Limited Company in Kingston area, suit working engineer/hardener. Reasonable price quick settlement.—Initial enquiries, BOX No. E2177, "The Engineer." O

MANAGING DIRECTOR RETIRING invites applications from qualified Engineer with technical and/or commercial experience and finance to purchase major shareholding.—BOX No. E2178, "The Engineer." O

BUSINESSES and PREMISES

YORKS : Engineering Works including Foundry. Total area 13,000 sq. yds. ; covered area 75,000 sq. ft. All services. Overhead Cranes up to 10 tons. No machine tools. Some Foundry plant. Suit various trades.—BOX No. E2180, "The Engineer." L

MEDIUM SIZED ENGINEERING CO. would consider offers to purchase plant, lease, stock, orders as a going concern. Three months full order book, but lack of finance prevents necessary expansion. 14,000 sq. ft., of which 5000 vacant. Excellent plant. Write in strict confidence.—BOX No. E2187, "The Engineer." L

MACHINERY Etc. WANTED

WANTED DRAFTING MACHINE Simplon Straight Edge Type.—Reynolds, 85, Newnham Avenue, Bedford. 67912. E2179 F

WANTED—1 Secondhand Bliss 12A or 12B Semi-Automatic Double Seaming Machine in good working order. State lowest price.—BOX No. E2186, "The Engineer." F

TWO SECONDHAND NO. N3 HEENAN AND FROUDE NAIL MACHINES REQUIRED.—Advise age, price and condition.—BOX No. E2185, "The Engineer." F

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600

HYDRAULIC SCRAP BALING PRESS, by Rose, Downs and Thompson. Baling box 4ft. 2in. by 1ft. 6in. sq., with hinged counterbalanced lid and locking arrangement. The horizontal glanded ram is 7¼in. diam. by 3ft. 2in. stroke, and exerts load 33 tons. Downstroking glanded ram 11¼in. diam. by 1ft. 7in. stroke and exerts load 75 tons. Underneath baling box is further horizontal piston type hydraulic ram, which ejects the finished bale. Operation of the press is through central valve by vertical three-throw hydraulic pump rams 2½in. diam. by 4in. stroke. Working pressure 1500 lb./sq. inch, capacity 2 g.p.m., 17 h.p. motor and starter, 440/3/50 electric supply.

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SONS AND CO. LTD.
SUNBEAM ROAD, N.W.10.
Tel.: Elgar 7222/7.
STANNINGLEY, Nr. LEEDS.
Tel.: Pudsey 2241.

E204 G

ROWLAND DOUBLE-ENDED MOTORISED SCALING MACHINE for sale. For cleaning the edge of sheet metal prior to resistance welding. Length by width of table 16in. by 4in. Sheets of any length may be passed through the machine. Double-ended motor suitable for 400/3/50. Grinding wheel 6in. diameter by ¼in. face. Photo and details from F. J. Edwards Limited, 359, Euston Road, London, N.W.1, or 41, Water Street, Birmingham, 3. E9154 G

NISSEN TYPE HUTS for sale. Prompt despatch of 16ft., 24ft. and 30ft. wide huts ; also "Romney" Huts, 35ft. wide, and "Blister" Hangars, 86ft. 6in. and 91ft. wide. These buildings are in various lengths and comprise steel framework with galvanised corrugated steel sheeting.—Full details from Dept. 115, J. Thorn and Sons, Ltd., Brampton Road, Bexleyheath, Kent (Tel. Bexleyheath 305). E113 G

FOR SALE

VALES PLANT REGISTER LIMITED
OFFER FOR IMMEDIATE SALE

NEALS 1-ton "D" CRANE, 20/30ft. swan-neck sectional jib, Ruston 1-VSH engine, on pneumatics. D 100 series. New 1946. Good condition. £750.
JONES KL22 2-ton Diesel Mobile CRANE, 24ft. jib, on solids. New 1948. Good order. £975.
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ANDERSON GRICE 3-ton Electric Derrick CRANE, 120ft. jib, S.L.I. "As new." £1600.
JONES KL44 Diesel Mobile CRANE, 16ft. swan-neck jib. New 1952. Ruston engine. Good order £2250.
ALLEN T6K 4½/5-ton Lorry-Mounted Road Mobile CRANE. New 1948, with crane jib, skimmer and trencher, Dorman 4DWD diesel engine. First-class condition. £2350.
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BUTTERS 5-ton Electric Single-Motor Derrick CRANES, 105/110ft. jibs. New 1948/49. Good condition.
SMITH 5-ton Steam Loco. CRANE, 4ft. 8½in. gauge, 35ft. jib. New mid-1949. Good order. £850.
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BUTTERS and ANDERSON GRICE 7-ton Electric Derrick CRANES, 100/110ft. jibs, from £1750 each.
ANDERSON GRICE 10-ton Steam Derrick CRANE, 120ft. jib, V.G. condition.
COLES 12½-ton Fully Mobile CRANE, 45/80ft. jib. New 1950. £5500.
Further details, 14, Lower Grosvenor Place, London, S.W.1. Telephone : VICtoria 7531, 3501, 8080, 9886 (15 lines). E107 G

FOR SALE

5-ton Coles diesel-driven self-propelled Mobile Crane on pneumatics.
5-ton Morris Versatile diesel/elec. Mobile Crane on solid rubber tyres.
5-ton Smith Steam Loco. Crane, 4ft. 8½in. gauge, 35ft. jib, new 1949.
6-ton Rapier Super pet./elec. Mobile Crane on solid rubber tyres.
6-ton Rapier Standard pet./elec. Mobile Crane on solid rubber tyres.
½ cu. yd. Rapier 410 diesel-driven Excavator with 4-purpose or dragline equipment.
½ cu. yd. Rapier 423 diesel-driven Excavator with shovel equipment.
1 cu. yd. Rapier 440 diesel-driven Excavator with shovel or dragline equipment.

WILLIAM G. SEARCH, LIMITED,
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SEARCH (LIVERPOOL), LIMITED,
HAMMOND ROAD,
KIRKBY TRADING ESTATE, LIVERPOOL.
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E8923 G

GRINDING MACHINE

NEWALL Type L.A. 10in. by 48in. Heavy-Duty Hydraulic Plain Cylindrical GRINDING MACHINE, with oscillating wheelhead and equipment. Late type machine.

F. J. EDWARDS LTD.,

359–361, EUSTON ROAD, LONDON, N.W.1.
EUSton 4681 and 3771.

E9097 G

A.C. ELECTRIC OVERHEAD TRAVELLING CRANES

7½-ton capacity Aabacas, 3-motor Type, cabin-controlled, 31ft. span, 20ft. lift., new 1953.
5-ton Anderson Grice, 47ft. 9in. span, 24ft. lift, new 1942.
3-ton Anderson Grice, 36ft. 3in. span, 24ft. lift, new 1942.
2-ton Morris, 28ft. 6in. span, 16ft. lift, new 1942.
200 h.p. Sentinal Steam Shunting Locomotive, new 1956, type 0–6–0, standard gauge, oil-fired (3 available).
600 h.p. totally enclosed, Double Reduction Gear, Oil-cooled, ratio 750/38·7 r.p.m., new 1942 by Turbine Gears, Ltd.

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GAS PRODUCER PLANT for sale, complete with all accessories. Capacity 300,000 cubic feet per hour. Inspection invited by appointment with: TUBES (EQUIPMENT), LTD.,
Broadwell Works,
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TWO BELLISS & MORCOM 2500 C.F.M. COMPRESSORS. 100 lb. w.p., 550 h.p. motors, 6600/3/50 supply. Used 4 years only. With Inter. and Aftercoolers, Receiver, Switchpanel. Available immediately.—FRED WATKINS (ENGINEERING), LTD., COLEFORD, GLOS. 'Phone : Coleford 2271/2/3. E139 G

MODERN COLES CRANE, self-propelled. Perfect condition. Diesel-driven, on pneumatics. Lift 6 tons. £3700.—J.C.C., 12, Kevelioc Road, London, N.17. E9104 G

Classified Advts. continued on page 140

FOR SALE

Edwards

RHODES No. 20 size Inclinable Power Press, fitted with Udal automatic press guards, pressure exerted approximately 20 tons., stroke 2in., centre to back 8in., size of bed 22in. by 40in., hole in bed 10½in. by 10½in. Weight approximately 20 cwt.

WESTON Model 400/100, Double-Sided Friction Screw Press of welded steel plate construction, arranged motor drive for 400/3/50, pressure exerted approximately 120 tons, maximum stroke 11in., diameter of screw with four starts 6½in., size of bed 21½in. by 18in. Weight approximately 5 tons.

THREE NEW BESCO Motorised Geared Angle Bending Machines, undercrank type, arranged motor drive for 400/3/50, complete with top and bottom 90 degrees vee forming tools, capacity mild steel 5ft. by 14 S.W.G., length of tools 6½in., stroke of top beam 2½in., maximum daylight bed to top beam 8½in., number of strokes per minute 21. Weight approximately 52 cwt.

BRADLEY & CRAVEN Power Geared Open-Ended Guillotine Shearing Machine, undercrank type, capacity 84in. by ¼in., gap in open ends 4½in., fitted with automatic sheet hold-down and adjustable gauges. Weight approximately 75 cwt.

QUICKWORK No. 321, Motorised Rotary Shearing Machine, with circle cutting attachment, arranged motor drive for 400/440/3/50, capacity mild steel 14 S.W.G., cuts circles from 6in. to 60in. diameter, hand feed control lever enables operator to cut intricate shapes by hand. Weight approximately 18 cwt.

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Photographs of the above are available.

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BIRMINGHAM, 3.
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E208 G

NEW OVERHEAD CRANES

60-ton Goliath, by Clyde, 40ft. span, 5-ton auxiliary ; cab control, 400/3/50.
40-ton Goliath, by Babcock and Wilcox, 40ft. span, 5-ton auxiliary ; cab control, 400/3/50.
40-ton Adamson, standard cab control, 42ft. 3in. span, 400/3/50.
40-ton Clyde, 42ft. 3in. span, with 20-ton aux., unused.
30-ton Adamson, 42ft. 3in. span, 5-ton aux. ; new in cases.
20-ton Vaughan, 42ft. 3in. span, 6-ton aux., 17ft. lift, six available.
20-ton King, 42ft. 3in. span, unused.
10-ton Goliath, by Morris, 40ft. span, cab control, 22ft. lift, 400/3/50.
Surplus Unused Ministry Cranes, mainly still packed. Drawings on request. Inspection invited. Bargain prices.

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FOR SALE

5340-ton HYDRAULIC RUBBER DIE PRESS by John Shaw, rubber pad 6ft. by 4ft., with self-contained Pumping Equipment.

2000-ton HYDRAULIC FORMING AND DRAWING PRESS, die cushion, 12ft. 6in. by 7ft. 6in., with self-contained Pumping Unit.

800-ton HYDRAULIC FLANGING PRESS by Hydraulik, Duisberg, 3 main rams, 4 vicing rams, table 16ft. dia., daylight 10ft.

500-ton HORIZONTAL EXTRUSION PRESS for sections with self-contained oil Pumping Unit.

ABOVE ARE SELECTED ITEMS FROM OUR LARGE STOCK OF HEAVY PRESSES.

REED BROTHERS (ENGINEERING), LTD.,
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E9139 G

MERCURY TRACTOR equipped with Buffer Beams, suitable for shunting operations. Power unit—Morris Petrol Engine, 25 h.p. (R.A.C.). This is a reconditioned engine fitted in August, 1957. The vehicle is fitted with pneumatic tyres as follows : 27 × 6 twin at rear, and 23 × 5 single at front. The tractor is in good working order and still being used.

The Trailer unit is an ex-R.A.F. 10-ton bomb trolley with a 20ft.—10in. wheel base and a present carrying capacity of 8 tons because of the heavy duty fabricated platform which was added to the trailer when purchased from M.O.S. Disposals. The trailer is fitted with 4—10.50 × 13 pneumatic tyres.

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TWW

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All motorised for 400/440/3/50 cycles.

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E215 G

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E105 G

UNUSED SET OF PLATE BENDING ROLLS, capacity 32ft. by 1in. down to 6ft. by 2½in., mild steel plate ; 75 h.p. roll drive, 40 h.p. screw-down ; electrics 400/3/50.—BOX No. E9137, "The Engineer." G

35-TON ELECTRIC PORTAL WHARF CRANE built 1945. 35 tons at 60ft. fixed radius, 85ft. height of lift. Rail gauge 40ft., admitting 3 lines of standard gauge track. Electrics 440/3/50 with Ward Leonard Generator.—REED BROTHERS (ENGINEERING), LTD., Replant Works, Woolwich Industrial Estate, London, S.E.18. Telephone : Woolwich 7611/6. E9138 G

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Span	**48' 0"**
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Lifting Speed	**20 f.p.m.**
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200 AIR RECEIVERS, stocked up to 9ft. dia., 100 to 500 lb. pressure.
ELECTRIC MOTORS.—150 Totally Enclosed and Flameproof Motors up to 100 h.p.
CRANES.—Mobile 10-ton Lorain, lorry mounted, 30ft.-70ft. extendable jib ; 6-ton and 4-ton Coles Diesel-Electric ; 3-ton Jones Super 40 (3) ; Neals 2-ton Diesel, 20ft. jibs (2) ; Derrick, 10-ton Henderson Steam, 120ft. jib ; 5-ton Wilson Electric, 70ft. jib ; Steam Loco, 18-ton Brownhoist, 50ft. jib ; 10-ton Coles, 40ft. jib ; 8-ton Wilson, 35ft. jib ; 5-ton Smith, 50ft. jib ; 5-ton Cowans Sheldon, 50ft. jib ; 5-ton Grafton, 38ft. jib ; E.O.T. 40-ton Adamson, 42ft. span ; 20-ton Vaughan, 42ft. span (8) ; Goliath, 40ft. span, 60-ton Clyde, 40-ton Babcock, 10-ton Morris ; 5-ton Henderson, 24ft. 7½in. span, 1946 ; 5-ton King, 29ft. 3in. span ; 2-ton Morris, 18ft. span ; 2-ton Smith, 34ft. span.
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November 27	**Miscellaneous stores,** including :—	M.O.S. Storage Depot, **Rotherwas, Hereford.**	**RUSSELL, BALDWIN & BRIGHT, LTD.** (Dept. L), 20, King Street, Hereford. (Tel.: 4366.)
	Mack, Austin, Morris, Standard and Hillman diesel and petrol engines, front and rear axles, gearboxes and windscreen assemblies, tyres and inner tubes, M.T. spares, vehicle equipment, sparking plugs, batteries, electric motors, hacksaw and hacksaw frames, pedestal and pillar drills, circular saw, double sided 20 ton draw presses, Metalclad planer and thicknessing machine, vertical spindle moulder, Wolf and other grinders, Vickers pyramid hardness testers, arc welder, 1000 binoculars, wireless equipment, test sets, steel units, corrugated steel sheets, 400,000 sandbags, etc.		
December 2-3	**Machine tools and miscellaneous stores**	M.O.S. Storage Depot, **Byley, Middlewich, Cheshire.** (Sale at New Islington Public Hall, Ancoats, Manchester.)	**J. H. NORRIS & SON** (Dept. L), 9, Albert Square, Manchester, 2. (Tel.: Blackfriars 8373.)
December 5	**Miscellaneous stores**	Returned Stores Group, **Reed Hall, Colchester.**	**FENN, WRIGHT & CO.** (Dept. L), 146, High Street, Colchester, Essex. (Tel.: 3171.)
December 9	**Miscellaneous stores**	M.O.S. Storage Depot, **Ruddington, Notts.**	**WALKER, WALTON & HANSON** (Dept. L), Byard Lane, Bridlesmith Gate, Nottingham. (Tel.: 47271.)
December 16-18	**Miscellaneous stores**	M.O.S. Storage Depot, **Royal Arsenal, Woolwich, S.E.18.**	**FULLER, HORSEY, SONS & CASSELL** (Dept. L), 10, Lloyd's Avenue, London, E.C.3. (Tel.: Royal 4861.)

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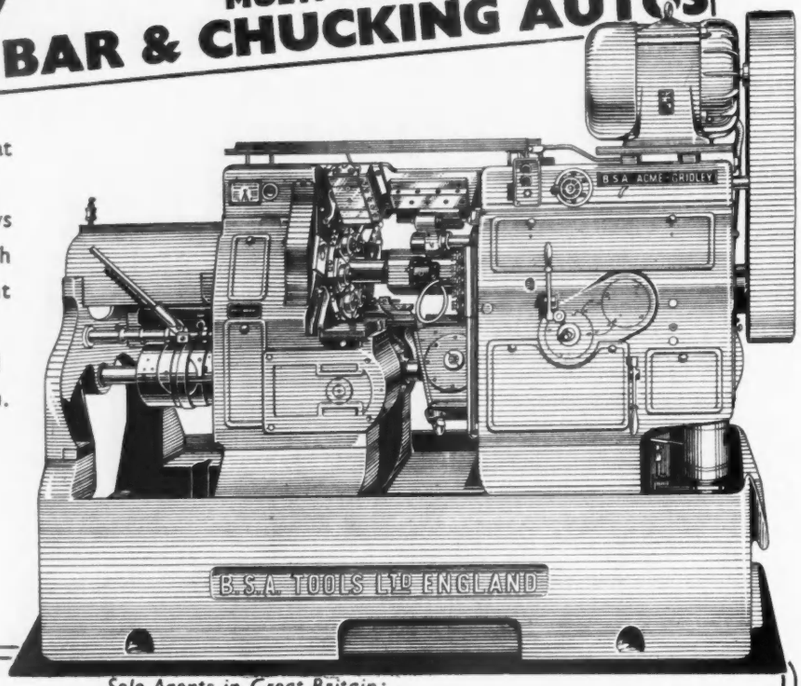

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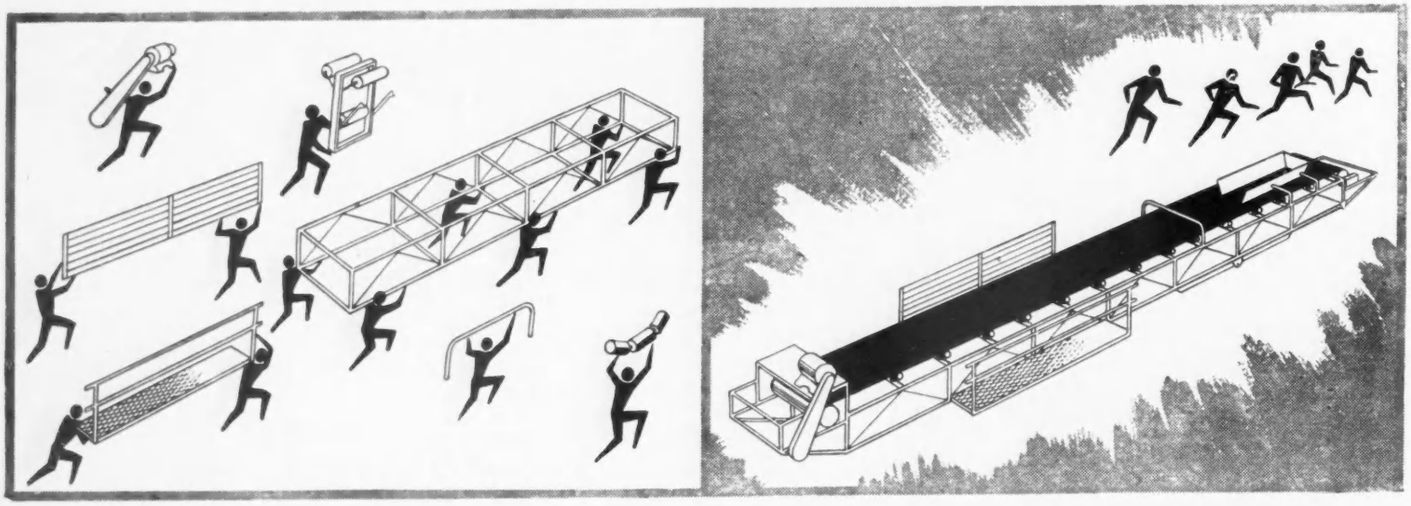

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INDEX TO ADVERTISERS

PAGE

AB Atlas Copco, Sweden Cover iii-49
Abbott & Co. (Newark), Ltd....110
Adamson, J. & Co., Ltd.....55
Airnesco Products, Ltd.....78
Alldays & Onions, Ltd.....56
Allen, E., & Co., Ltd.....69
Armstrong Patents Co., Ltd....58
Armstrong Stevens & Son, Ltd.....90
Automotive Products Co., Ltd. 21

B.I.P. Engineering, Ltd.....128
B.S.A. Tools, Ltd.....142
BTR Industries, Ltd.....112
Barlow & Chidlaw, Ltd.....19
Beakbane, H. (Fortox), Ltd....19
Bellman Hangars, Ltd.....45
Birfield Industries, Ltd.....85
Bird, W. H., & Sons, Ltd.....44
Birmingham Aluminium Casting (1903) Co., Ltd....109
Birmingham & Blackburn Construction Co., Ltd.....118
Birtley Engineering, Ltd.....127
Blakeborough, J., & Sons, Ltd. 76
Booth, J., & Bros.....53
Brett's Patent Lifter Co., Ltd.. 67
Bridges, G. F., Ltd.....33
British Aluminium Co., Ltd....99
British Constructional Steelwork Association .....Cover i
British Electrical Repairs, Ltd. 77
British Ermeto Corp., Ltd.....104
British Jeffrey-Diamond, Ltd.. 33
British Paints, Ltd.....6
British Steel Founders Association 13
Brookhirst Switchgear, Ltd.....91
Broom & Wade, Ltd.....10
Brown, E. G., & Co., Ltd.....30
Brown, N. C., Ltd.....131
Brownlie & Murray, Ltd.....112
Burnley Aircraft Products, Ltd. 86
Burrell, E. C., & Sons, Ltd.....33
Butcher, H., & Co.....141
Butterley Co., Ltd.....64

Caird, F., Ltd.....73
Callow, F. E. (Engineers), Ltd..103
Carron Co.....43
Carruthers, J. H., & Co., Ltd...104
Caston Barber, Ltd.....15
Chance Bros., Ltd.....122
Chesterfield Tube Co., Ltd.....103
Clark, G., & Sons (Hull), Ltd...123
Clarke, Chapman & Co., Ltd.... 8
Clyde Blowers, Ltd.....74
Clyde Crane & Booth, Ltd.....53
Clyde Crane & Engineering Co. 53
Clyde Rubber Works, Ltd.....56
Clydeside Machine Tool Co., Ltd.....98
Cochran & Co., Annan, Ltd.....68
Confederation Life Association 59
Crabtree, J. A., & Co., Ltd.....41
Craufurd Fabrications, Ltd. ..80
Crofts (Engineers), Ltd. 82-83
Cross Manufacturing Co. (1938), Ltd.....94
Crowthorn Engineering Co., Ltd.....59
Cummins Diesel Sales & Service, Ltd.....106

Danks of Netherton, Ltd.....114
Darwins Group.....113
Davies & Metcalfe, Ltd.....2
Dilloway, P. W., Ltd.....22
Dorman Long.....11
Drum Engineering Co., Ltd.....43
Dunlop Rubber Co., Ltd.....14
Dzus Fasteners, Europe, Ltd... 59

Eagle & Wrights (Gauges), Ltd.122
Edwards, L., & Co. (Engineers), Ltd.....117
Electrical Energy.....137
Electronic Computer Exhibition 4
Electronic Engineering.....143
Elliott-Lucas, Ltd.....33
Ellison, G., Ltd.....29
Eltron (London), Ltd.....130
English Electric Co., Ltd.....79
Extrudex, Ltd.....101
Eyre Smelting Co., Ltd.....133

Farmer, L., & Sons 141
Fenner, J. H., & Co., Ltd.....36
Finucane, W., Ltd.....67
Firth Brown Tools, Ltd.....27
Firth-Vickers Stainless Steels, Ltd.....37
Foord, J., & Co.....141
Freeman, Taylor Machines, Ltd.....133
Fuller Electric, Ltd.....31
Fuller, Horsey, Sons & Cassell141

PAGE

Gardiner, Sons & Co., Ltd.....124
Gear Grinding Co., Ltd.....62
Geipel, W., Ltd.....130
General Electric Co., Ltd.117-130
General Refractories, Ltd.....110
Gibbins, R. C., & Co., Ltd....119
Glenfield & Kennedy, Ltd. Cover ii
Goodwin, R., & Sons (Engineers), Ltd.....77
Grafton Cranes, Ltd.....71
Grazebrook, M. & W., Ltd. 143
Greenwich Insulation Co., Ltd. 93
Greenwood & Batley, Ltd.....32
Greenwood's Standard Gear Cutting Co., Ltd.....43

Harland & Wolff, Ltd.....52
Harlow, R., & Son, Ltd.....71
Harvey, G. A., & Co. (London), Ltd.....61
Head Wrightson Teesdale, Ltd.120
Heap, J., & Co., Ltd.....96
Henley Foundries, Ltd.....118
Hillside Foundry & Engineering Co. (Cupar), Ltd.....55

Imperia Aggregatebau Autohaus Muller oHG.....129
Imperial Chemical Industries, Ltd.....39-63
Ince Forge Co.....78
Ironsides Lubricants, Ltd.....78

Jackman, J. W., & Co., Ltd.....96

Kay, S., Rubber Co., Ltd.....44
Kaye, E. & E., Ltd.....16
Keith Blackman, Ltd.....6
Kempe's Engineers Year-Book.129
Klinger, R., Ltd.....144
Knight, Frank & Rutley.....141
Krupp, Fried.....51

Lafarge Aluminous Cement Co., Ltd.....17
Langley Alloys, Ltd.....34
Laurence, Scott & Electromotors, Ltd.....3
Ledward & Beckett, Ltd.....73
Leeds Engineering & Hydraulic Co., Ltd.....16
Lewin Road Sweepers, Ltd.....115
Loveridge, Ltd.....67

PAGE

Lucas J. (Hydraulic & Combustion Equipment), Ltd..... 9

Machinery Installations, Ltd.... 44
MacLellan, P. & W., Ltd..... 46
McNeil, C., Ltd.....130
Mallinson & Eckersley, Ltd...143
Mancuna Engineering, Ltd..... 98
Manganese Bronze & Brass Co., Ltd.....87
Marconi Instruments, Ltd.....60
Massey, B. & S., Ltd.....125
Matthew Hall Group of Companies.....28
Matthews & Yates, Ltd.....42
Maxim Conveyors (England), Ltd.....142
Maxseal Valves, Ltd.....98
Metal Structures, Ltd.....103
Metropolitan Cammell Carriage & Wagon Co., Ltd. 116
Metropolitan - Vickers Electrical Co., Ltd.....12
Midgley & Sutcliffe, Ltd.....46
Midland Silicones, Ltd. 7
Millars' Machinery Co., Ltd...134
Mills, G. (Engineers), Ltd.....59
Mirrlees (Engineers), Ltd. 132
Mobil Oil Co., Ltd.....48
Mould, A. H., & Sons, Ltd....121
Mountford, J., & Co., Ltd.....52
Mutual Finance, Ltd.....121

Neal, R. H., & Co., Ltd.....126
Neill, J., & Co. (Sheffield), Ltd 67
Newall, A. P., & Co., Ltd..... 97
Newton Sales Co., Ltd.....124
Niagara Screens (Great Britain), Ltd.....101
Non-Ferrous Die Casting Co., Ltd.....55
Norris Bros., Ltd.....112
Norton, Sir J. Farmer & Co., Ltd.....5

Oddie Bradbury & Cull, Ltd...132

Palnut Co., Ltd.....112
Parsons, C. A., & Co., Ltd.....108
Peckett & Sons, Ltd.....124
Pegler & Louden, Ltd.....100
Peglers, Ltd.....118
Permoglaze, Ltd.....93
Pinchin, Johnson & Co.....101
Pitman, Sir Isaac, & Sons, Ltd 137
Platt Malleable Castings, Ltd.112
Plowright Bros., Ltd.....97
Pollard, F., & Co., Ltd.....34
Positive Lock Washer Co., Ltd. 43
Powder Couplings, Ltd.....68
Power Petroleum Co., Ltd.....40
Powis, D., & Sons, Ltd.....115
Premier Spring Co., Ltd.....121
Price, J. T., & Co., Ltd.....39
Priest Furnaces, Ltd.....78
Prior Stokers, Ltd.....46

Rawlplug Co., Ltd.....15
Reavell & Co., Ltd.....116
Record Electrical Co., Ltd.....90
Rendale Cranes, Ltd.....95
Renold Chains, Ltd.....50
Renshaw Foundry, Ltd.....117
Research Engineers, Ltd.....78
Reyrolle, A., & Co., Ltd.....89
Rhodes, B., & Son, Ltd.....94
Rhodes, Gill & Co., Ltd.....130
Richards, C., & Sons, Ltd.....34
Richards, J., & Sons, Ltd.....75
Richards & Partners.....141
Richmond Welding Co.....74
Riley, A. J., & Son, Ltd.....90
Robertson & Ferguson, Ltd.....5
Robertson Thain, Ltd.....20
Robson, G., & Co. (Conveyors), Ltd.....77
Rockwell Machine Tool Co., Ltd.....94
Rubber Bonders, Ltd.....88
Rubber By-Products (Warwickshire), Ltd.....121
Ruhrstahl, A.G.....102
Russell, S., & Sons, Ltd.....100

Sadi Engineering Co., Ltd..... 71
St. Georges Engineers, Ltd..... 77
Sale, H. B., Ltd.....132
Schieldrop & Co., Ltd.....103
Shell-Mex & B.P. Gases, Ltd.. 45
Simmons & Hawker, Ltd..... 96
Skefko Ball Bearing Co., Ltd... 72
Small, W. H., Ltd.....30
Smedley Bros., Ltd.....74
Smith, C. & B., Ltd.....115
Smith, J. (Keighley), Ltd.....111
Smith, S., & Sons (England), Ltd.....107
South Durham Steel and Iron Co., Ltd..... 23

PAGE

Somers, W., Ltd..... 70
Standard Piston Ring & Engineering Co., Ltd..... 19
Standard Telephones & Cables, Ltd.....129
Steelway, Ltd.....106
Stewarts & Lloyds, Ltd..... 25
Stone, J. B., & Co., Ltd..... 35
Stream-Line Filters, Ltd.....122
Stubs, P., Ltd.....73
Summerson, T., & Sons, Ltd...131
Swain, J., & Son, Ltd.....18
Sykes, H., Ltd.....54

Taylor & Hubbard, Ltd..... 56
Taylor Stoker Co., Ltd..... 74
Teale, J. W., Ltd.....110
Technological Institute of Gt. Britain.....136
Thompson, J. (Wolverhampton), Ltd.....Cover iv
Tilghmans, Ltd..... 92

United States Metallic Packing Co., Ltd..... 18
Unbrako Socket Screw Co., Ltd..... 30

Vickers - Armstrongs (Engineers), Ltd..... 38
Visco Engineering Co., Ltd..... 2
Vokes, Ltd..... 24

Walker, J., & Co., Ltd..... 81
Ward, T. W., Ltd.....47-140
Welding Technical Services, Ltd.....114
Wellman Bibby Co., Ltd..... 94
Wellman Smith Owen Engineering Corporation, Ltd..... 66
Wells, A. C., & Co., Ltd..... 74
Welsh Metal Industries, Ltd.. 57
West Ham Testing Laboratory 132
Weston, C., & Co., Ltd..... 84
Westool, Ltd..... 75
Wheatley Kirk, Price and Co.....141
Whitehouse Industries, Ltd.... 26
Wiggins, F., & Sons 143
Wiggin, H., & Co., Ltd..... 78
Wood, E., & Co., Ltd..... 65
Wootton Bros., Ltd..... 98
Worthington-Simpson, Ltd....105

Zerny Engineering Co., Ltd.... 16

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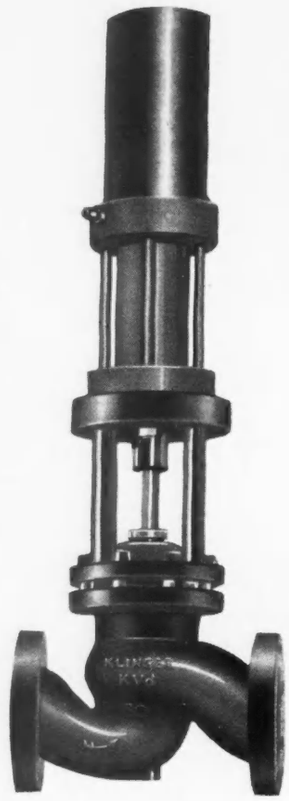

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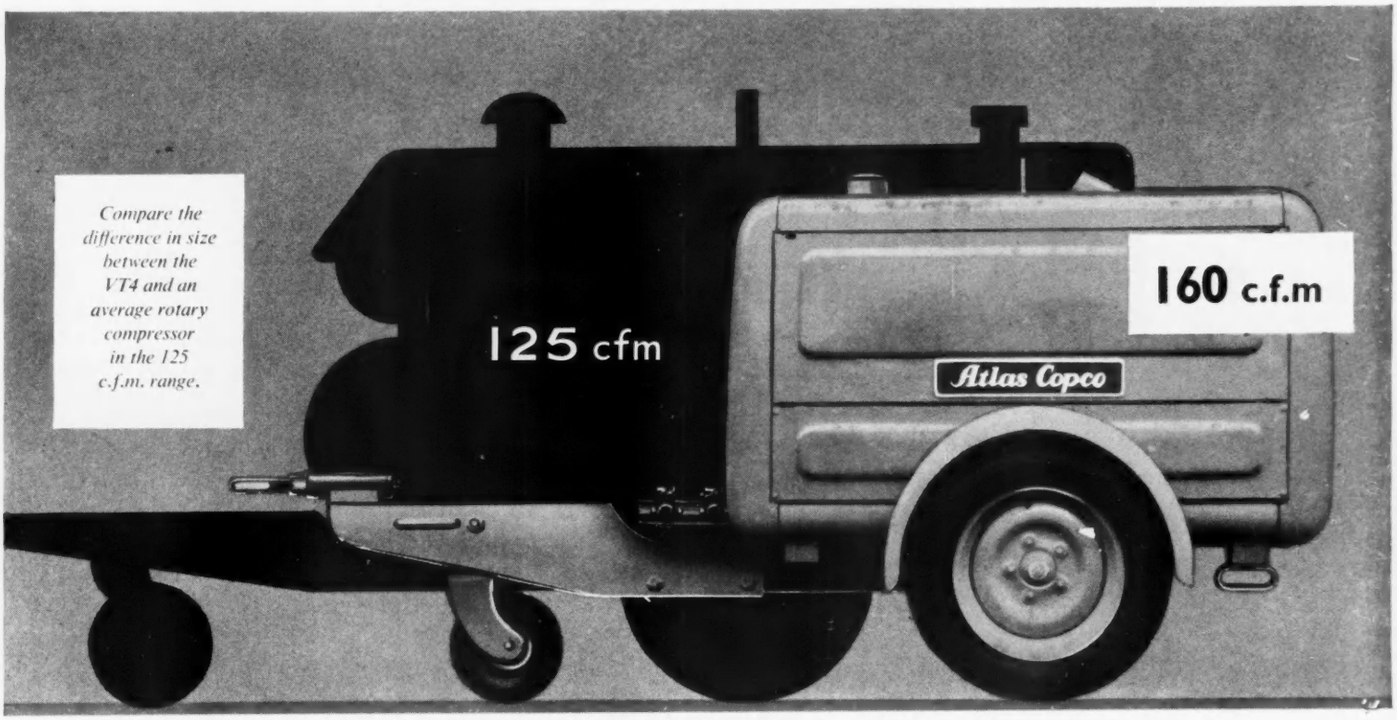
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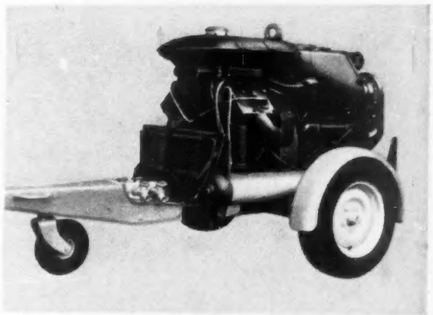

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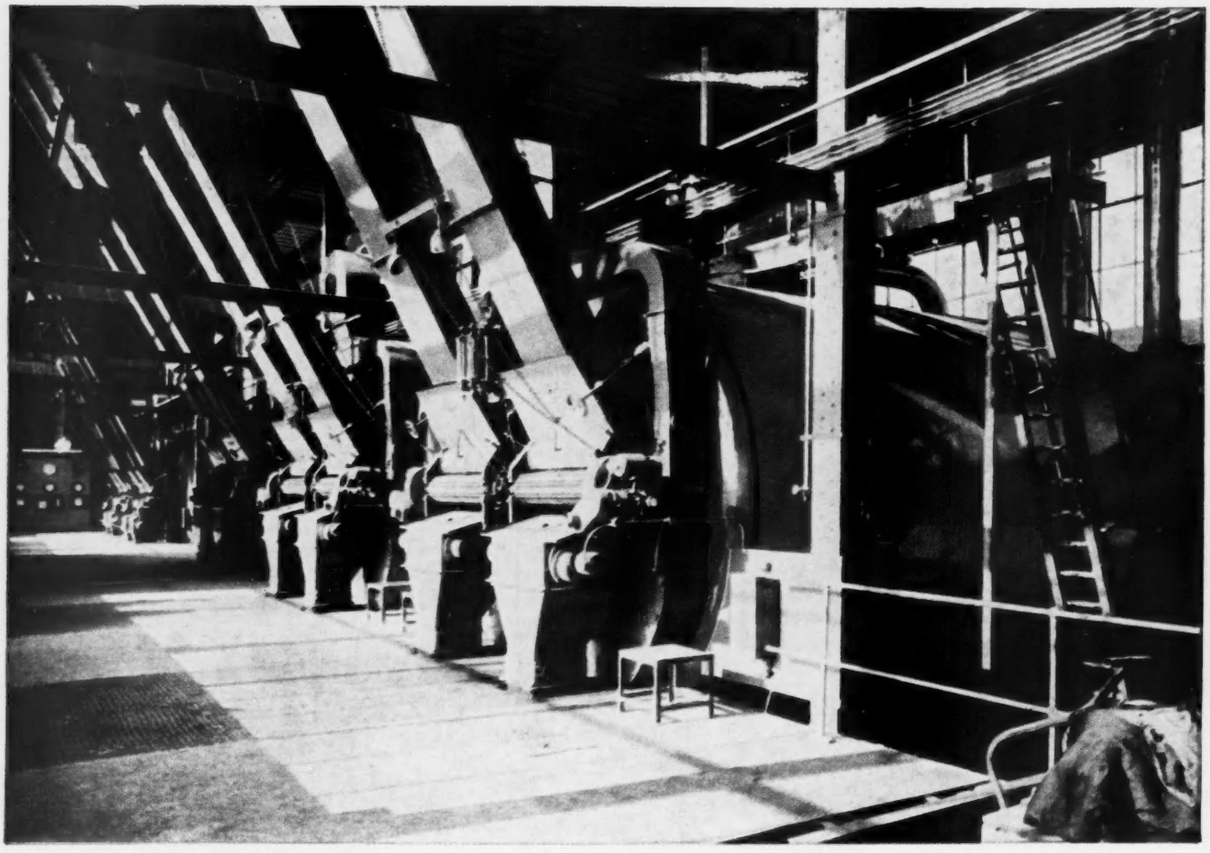

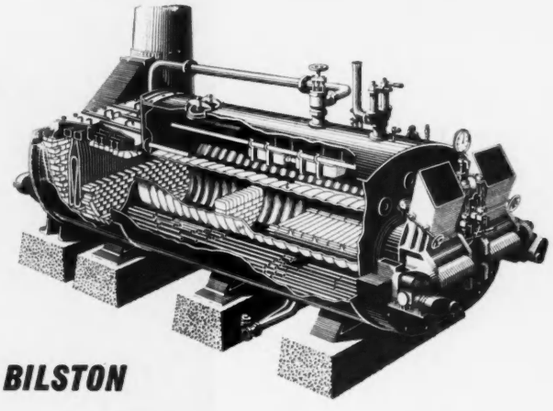

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